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A NATURALIST IN THE STRAITS OF MAGELLAN[1]

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IT was in January and February of the misty Antarctic summer that we lingered for a month along the seven hundred miles of Magellan Strait and Smythe Channel. The delicate flowers of a December springtime were passing out of bloom giving place to flowers of longer duration, and young land birds were all out of their nests.

The uneven plains of eastern Patagonia and Tierra del Fuego were green with grass and low shrubbery and the mountains along the western channels dark with unbroken forests of evergreen beech. Our course along salt-water passages was marked by somewhat gustier weather than would have been found a short distance inland, but it was not uncomfortably chilly for explorations ashore in daytime, and days are long in summer at fifty-three degrees latitude, both south and north. It was in fact pleasanter in the straits than we had found it shortly before at Montevideo and Buenos Aires—a thousand miles nearer the tropics—where "pamperos" had been blowing wildly along the great river.

It was pleasant to escape from the unfriendly South Atlantic and enjoy the easy progress of a vessel on even keel. Still more agreeable was the panorama of passing shores and the abundant animal life of the channels and their islands. Best of all were the intimate observations of the aspects of nature, permitted by our daily explorations on land, the *Albatross* always within reach as a home camp, anchored in some protected harbor.

To the naturalist a voyage of exploration through the Straits of Magellan is a rare privilege, not only on account of the strangeness of its animal and plant life and the wonders of its scenery, but also because of the records of scientific discovery associated with it. We were following in the wake of Darwin and the *Beagle,* although more than half

[1] Illustrated by photographs made by Mr. Thomas Lee and the writer.

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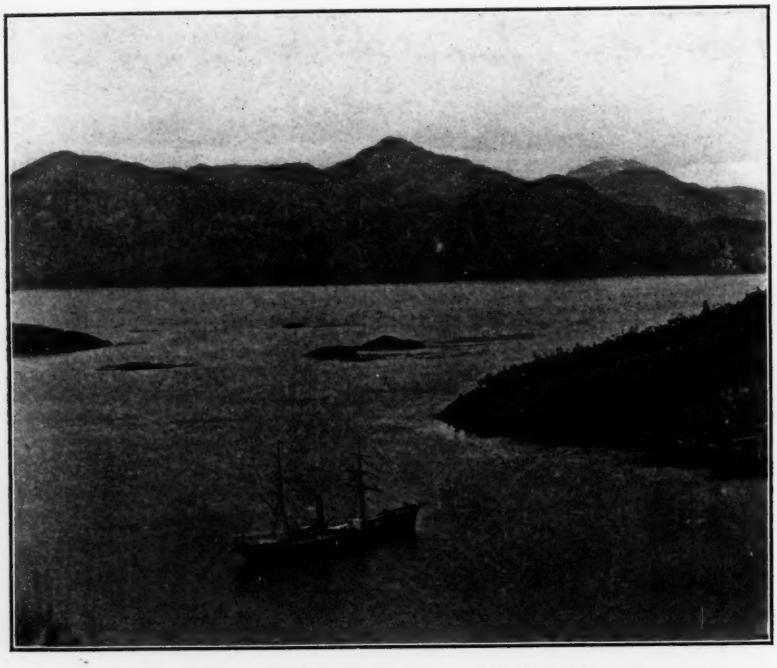


U. S. S. ALBATROSS IN BORJA BAY. Straits of Magellan.

a century later, and had read the quaint descriptions of the region by Magellan, Drake, Cook and the hardy sea explorers who followed them.

Out in the straits whales, porpoises and seals made their presence known at times, but sea birds were more constant objects of interest. The nesting places of cormorants were marked by masses of black-backed, white-breasted birds, acres in extent. From low island levels Cassin terns rose in clouds of protesting thousands when our boats grounded.

"Steamer" ducks[2] kept well ahead of the active oarsmen, their flightless wings aiding their webbed feet in a manner suggestive of paddle wheels used as auxiliaries to screw propellers, trailing a foamy wake a hundred yards behind. The species belongs exclusively to southern South America and is altogether the most notable bird of the straits region. It is said to weigh over fifteen pounds. While it can not, or at least does not, fly, and is seldom inclined to dive, the rapidity of its progress over the surface long ago attracted the attention of explorers and navigators. Most observers are of the opinion that the wings move alternately when in motion. An occasional penguin—that flightless, burly diver, peculiar to Antarctic seas—only showed himself above water in porpoise-like leaps and was seldom easy to get.

The diving petrel,[3] also Antarctic in range, was by special request a mark for all guns, but no specimens were taken. As a quick diver it

[2] *Tachyeres cinereus.*

[3] *Pelecanoides urinatrix.*

is a little brother to the northern auklet, which it resembles in appearance and to some extent in habits. When at large there is nothing in its actions to suggest the petrel. It strikes down into the water from full flight, emerging farther on, fairly bursting forth into the air with wings in rapid motion.

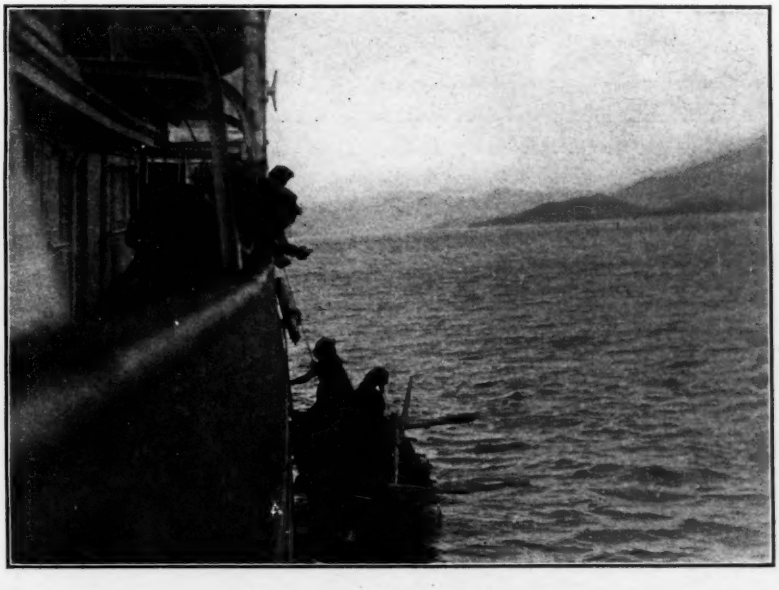
There were also gulls, jægers and grebes along the great waterway. Albatrosses and Cape Horn pigeons did not follow us into the straits, but we found them awaiting the ship when we emerged into the Pacific a month later.

About the marshy places, ducks, geese, plovers and snipes of unfamiliar kinds afforded sport as well as ornithological specimens on our trips ashore. The Paraguay snipe proved a good substitute for the Wilson snipe of North America. Most striking in appearance were the large kelp geese, the males of which are snowy white and the females dark.

The barred Magellan geese, however, are more important on account of their abundance. This bird is a resident of the region throughout the year. It is an inhabitant of the open plains and mountain slopes and is a land rather than a water species. It occupies the open country of Tierra del Fuego in enormous numbers and has contributed more to the food of the white settlers now establishing sheep ranches in that country and in Patagonia than any other wild creature.

With few exceptions both land and water birds were species of the southern hemisphere and of Antarctic distribution.

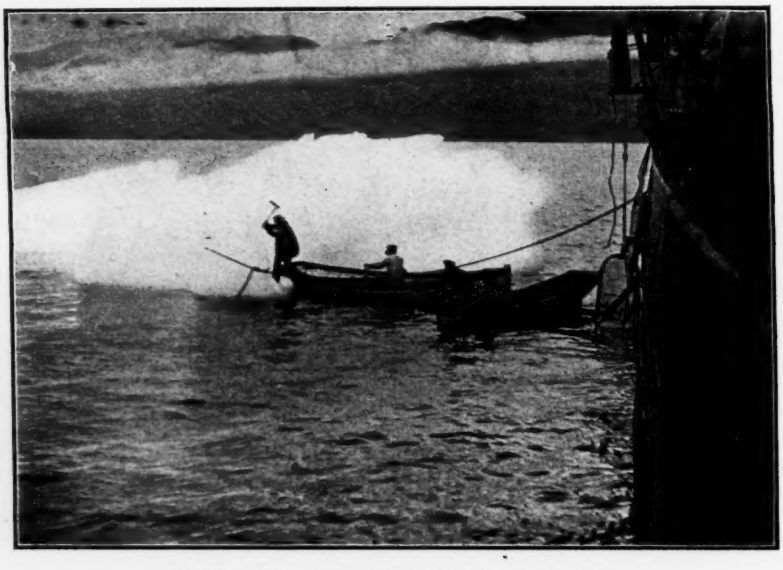
The Magellan robin would have passed for the North American bird but for its gray tones and its disinclination to sing. There were



NATIVES. Straits of Magellan.

wrens, swallows, finches, flycatchers and hawks to be seen daily, but all in unfamiliar guise.

The Great Magellan owl was enough like our great horned owl to be taken for the same bird. The same might be said of two pygmy owls shot at Laredo Bay, which closely resemble those of our western states and are among the smallest of known owls. The Magellan pygmy, notwithstanding the abundance of its fluffy plumage, is a mere featherweight of less than four ounces. The burrowing owl and spar-



GLACIER ICE. Ayre Sound, Straits of Magellan.

row-hawk did not differ appreciably from home species. In these latitudes the burrowing owl inhabits excavations made by the "viscacha," a rodent of the chinchilla family which lives in communities after the manner of our northern "prairie dog." Lacking the viscachas' burrow, it digs its own. The common barn owl and short-eared owl of world-wide distribution were both present.

Kingfishers, woodpeckers and goldfinches were masquerading along the straits in strange garb, and best disguised of all, a meadow lark with bright crimson breast.

A courageous species of humming-bird[4] penetrates southward into the chilly wilds of Fuegia, and we procured specimens within a few hours of a snow squall which greeted us in one of the western channels. The Patagonian burrowing parrot we found within a few miles of Punta Arenas, where it seemed as much out of place in the driving mist as it would in Alaska.

In the dense forests along Smythe Channel we heard and obtained

[4] *Eustephanus galeritus.*

the "barking bird,"[5] a thrush-like ground bird whose sharp notes suggest the presence of a small dog. The condor and buzzard were frequently seen.

One of the most interesting of the birds is the quail-like *Attagis*, a species of the Limicolæ inhabiting the open uplands. Darwin refers to their rising and flying like grouse and says they occupy the place of ptarmigan of the northern hemisphere.

The most familiar bird of the straits is a species of creeper[6] which follows the hunter constantly through the forest. The Cape Horn wren is as saucy as a wren can be, and the marsh wren creeping through the grass like a mouse, is almost familiar enough to be caught with a butterfly net.

Of the hundred or more species of birds to be found along the straits we obtained about seventy, three of which belonging to the family of "wood-hewers"[7] were new to science. Our bird collection numbered one hundred and seventy specimens in all. The variety of migratory birds was greater than we had expected, but South America has a wonderfully varied bird fauna, and why should not the migrants fly southward in springtime if summer is to be found in that direction? One has but to get used to a reversal of the seasons.

The natives had skins of puma, guanaco, deer and Patagonian ostrich, but none of these were observed alive, as our shore trips did not permit of extended journeys inland. The Magellan fox, otter and little striped skunk were easily obtained, the last going whole into a tank of alcohol sent ashore for the purpose, no one being sufficiently self-sacrificing to skin it. We could only hope that the alcohol would have a deodorizing effect, but I never had the courage to inquire of the curator of mammals of the Smithsonian Institution respecting an alcoholic specimen of *Mephitis patagonica* from the Straits of Magellan.

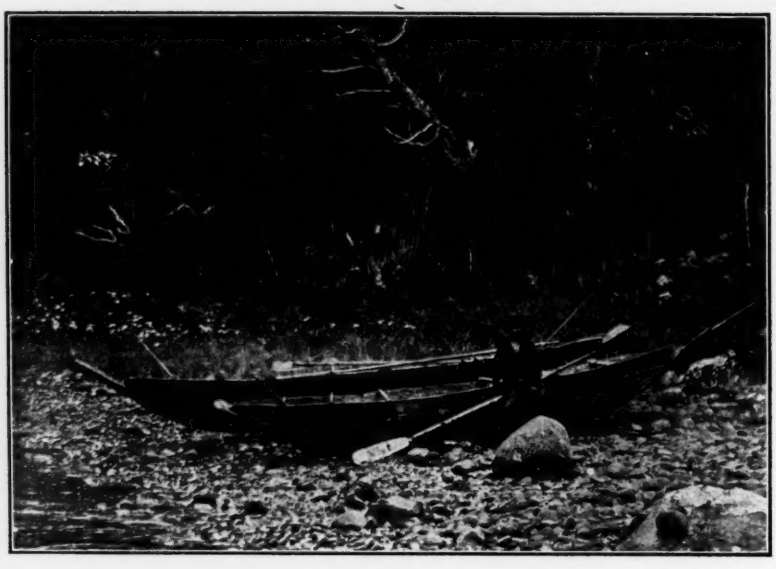
The inquisitive fox watched us everywhere from the bluffs, but the crab-eating otter quickly slid from the rocks into the tangles of giant kelp so abundant along the shores of this region.

From Punta Arenas a two days' journey was made in the steam launch to the Fuegian side in search of Antarctic fur seals. We met with these animals about thirty-five miles south of Punta Arenas, at St. Peter and St. Paul Rocks, where a number were lying on the rocks near the water. By landing on the opposite side the captain and I managed to stalk them, killing three with our Winchesters before they could take to the sea. After the seals had been skinned for museum specimens, the carcasses were eagerly appropriated by a canoe load of hungry and more than half-naked Fuegians. While the men were stowing their wind-fall of fresh meat in the canoe, one of the women went foraging among the nests of some cormorants near by, taking all

[5] *Pteroptochus.*

[6] *Oxyurus spinicauda.*

[7] *Dendrocolaptidæ.*



FUEGIAN CANOES. Straits of Magellan.

the half-grown young she could carry, staying her appetite meanwhile with such raw eggs as could be found. Another woman was busy at the characteristic occupation of baling, for all Fuegian canoes leak, not being dugouts, but made of the roughest of native-hewn slabs lashed together with tough vines or rootlets and caulked with mosses. A third woman and a child seemed to be warming food over a fire and incidentally warming their own nearly naked bodies. The party had no knives and borrowed one of ours to cut up their meat.

Their backs were partly protected by guanaco skins, tied around their necks with the hair side out. These primitive capes were not otherwise fastened and, when the hands were in use, left the body quite exposed to the wind. None of the canoe Indians that we saw had more clothing, except in a few cases where they used portions of cast-off sailor clothes, and none fastened their fur capes about the body with so much as a string.

There is always a low fire burning on a bed of earth in the bottom of the Fuegian canoe wherever it may be met with, making possible the serving *en route* of smoked cormorant and baked mussels, but the indications did not always point to that use of the fire, some of the food at least being eaten raw. It is doubtless necessary for these wandering shellfish gatherers to maintain a permanent camp fire; to light it anew on their rain-saturated shores must tax their ingenuity to the utmost. A careful search of the canoes revealed neither flint nor matches, and the Fuegian has no pockets. This was our first meeting with the canoe Indians. Later we encountered them among the western channels, but never more than two canoes could carry. They were always eager to come aboard the ship and to trade their bone-pointed spears, bows and

arrows, or rough paddles for ship biscuit and misfit clothing. They were even willing to trade their children. The canoe was apparently the only article not for sale. It seems to represent home and fireside, the few brush and leaf-covered bowers we saw on shore being merely hastily made night camps and wet ones at that. The canoe conveys the people from mussel bank to sea-bird rookery in the continual search for food. It is not likely that they often get seals, as their spears appear too rude—merely short poles with the bark on, the bone points being tied on in the roughest manner. Besides there never seemed to be enough seal skins to provide each member of the group with a cover for his shoulders. Naked children huddled close to their mothers for shelter from wind and rain. We made no measurements, but my recollection is that none of these savages exceeded five feet in height. The faces of the adults were all utterly barbarous. We saw but one dog among these people, where he may have been of more importance as possible food than as an aid in the capture of food. It is not unlikely that the natives get plenty of young seals during the season when the animals are breeding on the outlying rocks.

In Punta Arenas I purchased from a trader a rough Fuegian basket, but did not ascertain from what tribe it was derived.

Our photographs show Fuegians with clothing, but we had supplied it. We had at last found primitive man. It is doubtful if he exists in greater simplicity anywhere else to-day.

The natives of Fuegia are quite different from the Patagonian tribes and are known as the Onas, inhabiting the interior of Tierra del Fuego proper and subsisting largely by the hunt of the wild guanaco;

FUEGIANS. Otter Bay, Straits of Magellan.

the Yahgans of the Cape Horn region and the more southern parts of the archipelago, and the Alaculofs of the western channels, who like the Yahgans, are canoe Indians. All are disappearing in the face of the long, irregular warfare maintained between themselves and the white race. In half a century they have diminished from perhaps forty or fifty thousand to certainly less than one thousand. It is to be regretted that the canoe Indians have not been the subject of more study by ethnologists, as they probably are the least known of wild tribes, and the lowest in the scale of intelligence and development.

In the vicinity of Punta Arenas, which marks about the first third of the westward journey through the straits, the general aspect of the country undergoes a change. Hills and patches of forest appear. The climate also changes appreciably, the western part of the region being much more stormy and rainy. From this neighborhood may be seen to the southward on clear days the white summit of Mt. Sarmiento, nearly one hundred miles away. It is 7,000 feet in elevation —the highest peak in Tierra del Fuego—and its summit is as yet untrodden by man. Sir Martin Conway succeeded in reaching a height of only 4,000 feet when his party was driven back by appalling storms of sleet.

The resemblances to northern species which were noticeable among many of the birds, were traceable among the wild flowers. There were dandelions, buttercups, ground orchids, anemones, yellow violets, geraniums, gentians, yellow star-grass, primroses and marigolds, and probably hosts of others not observed because not in bloom. Many of those met with are unfortunately not namable except in botanical terms. Growing close to the ground and very striking was a large pink flower[8] of great beauty common along the western shores. There were ferns of many kinds. A barberry shrub[9] was found everywhere, and a fine currant bush[10] was often seen. Our greatest surprise was at the size and beauty of the *Fuchsia,* which forms thickets ten or twelve feet high and bears a wonderful abundance of flowers much frequented by humming birds.

The contradictions presented by nature were remarkable: with cold rain storms blowing over the mountains and beating fiercely down into the channels, chilly mists and lowering skies perhaps most of the time, we must yet believe it summer where, at the same time, humming birds, parrots and flamingoes, beautiful flowers and ripe berries are to be found. The line of perpetual snow is only 2,000 or 3,000 feet above tide water, while the mean summer temperature is about 50 degrees.

However mild and bright occasional days might be, the forests were always damp to the point of saturation. The excessive moisture

[8] *Philesia buxifolia.*

[9] *Empetrum.*

[10] *Ribes magellanicum.*

was favorable to certain large fungus growths on the trees, and used as food by the natives.

The chief constituents of the Magellan forest are the Antarctic beech,[11] the evergreen beech,[12] and the "winters bark[13] (of the magnolia order) with laurel-shaped leaves nearly four inches long. A so-called cypress[14] is conspicuously abundant along the western channels.

It was new and rich ground for the scientific prospector. The naturalists were not to be deterred by the weather, but penetrated the narrow side channels in the ship's boats, shooting, fishing, botanizing, shore-collecting at low tide, photographing, hammering mesozoic fossils from the rocks, digging in the ancient shell-heaps of the aborigines and bartering with the natives.

Suitable beaches for dragging the seines were not easy to find, but the sailors usually secured enough smelt and mullet-like fishes for the table and a considerable variety of finny oddities for the ichthyologist's alcohol tanks. The naval officers found sport for their trout rods, in taking a trout-like fish abundant in the small streams. They insisted on calling it a trout, but this peculiar genus, *Haplochiton,* of the austral fresh waters differs noticeably from the boreal fish in lacking the adipose fin of the true trouts. To the angler it is equally gamy. The ichthyologist ignoring the rules of the true sportsman, swept many of the best pools with his nets. His "specimens," it is needless to relate, did not appear upon the mess table, much to the protest of the anglers.

Collecting along shore at low tide yielded many interesting invertebrates. A univalve of the genus *Concholepas* clings to the rocks like a limpet. It is as large as a man's fist and deep enough for a drinking cup. I saw one in a canoe where it may have been used as a boat bailer. It is also said to be used by the natives as food. The large Chilian mussel[15] is abundant and seems to be the principal item in the food supply of the natives. We found it excellent eating and obtained specimens fully seven inches long. The handsomest sea shell of the straits is *Voluta Magellanica,* which reaches a length equal to that of the large mussel.

The most interesting crustacean was an isopod of the genus *Serolis,* which bears a superficial resemblance to the extinct trilobites and here takes the place of our North American horseshoe crab[16] as a notable zoological type. We obtained specimens of it in many localities along shore and also in our dredge hauls.

We were scarcely prepared to find frogs in this latitude, but four

[11] *Fagus antarctica.*
[12] *Fagus betuloides.*
[13] *Drimys.*
[14] *Libocedrus.*
[15] *Mytilus chilensis.*
[16] *Limulus polyphemus.*

very small specimens, representing three species, were secured, one of which proved to be new to science.

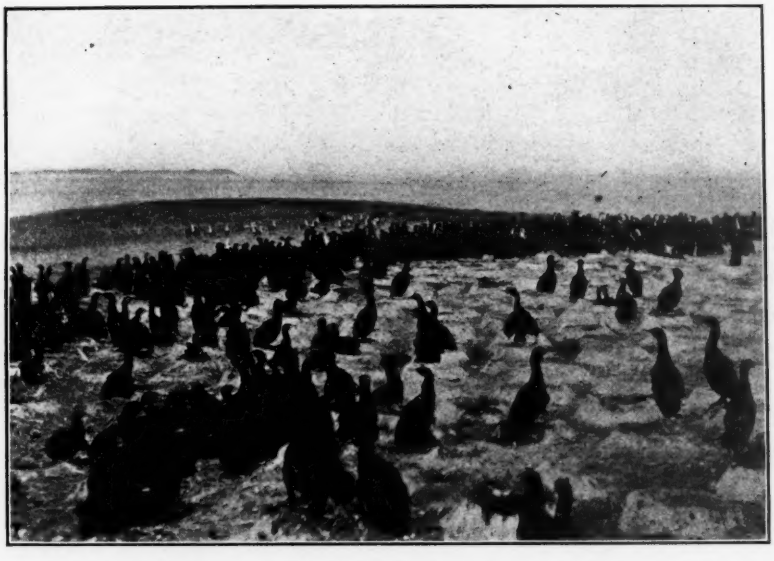
Of insect life we learned little, and our collections were unimportant. A few butterflies, moths and bees were seen, while beetles were more noticeable. Mosquitoes may be dismissed with the remark applied to the snakes of Ireland: there are none.

No exploring ship ever carried a more industrious scientific staff; its store of zoological and botanical plunder grew daily and the laboratory lights burned into the small hours for the identification of species and the preservation of specimens. The naval corps and the sailors also warmed up to the work, bringing in birds, mammals, fishes

CASSIUS TERN. Straits of Magellan.

and plants, some of them wielding the clumsy coal shovels from the fire-room, in digging ancient stone and bone implements from the shell heaps. Some of the shell heaps or "kitchen middens" as the archeologist called them, were several feet thick. Digging into them was laborious and the results called forth only contemptuous remarks from the sailors. A few arrow-heads, bone, flint and stone implements with bones of seals, and mussel and limpet shells did not seem to them worth the effort. But the ancient camp sites showed to those who could read their story, that the native population of the past had lived as simply as their descendants of the present, had subsisted on the same food, used the same primitive tools and camped on the same spots. There were doubtless more of them as barbarians decrease in numbers after contact with the white race.

Large mammals were, with the exception of fur seals and Antarctic sea lions, not common along the line of our operations, but foxes, otters, coypu, *Ctenomys* and other small fur bearers of the far south



STRAITS OF MAGELLAN. White-breasted cormorants. Santa Marta Island. Young birds in foreground.

were added to the ship's steadily increasing lists of the fauna and flora of the straits.

In the captain's private log there is a reference to the activities of the scientific staff, in connection with notes on very stormy weather at one of our anchorages, where it was too rough to send boats ashore:

It was fortunate for the naturalists, for it gave them a chance for a much-needed *rest*—they ceased work in the laboratory at 11:30 P.M. and were off at 4 A.M. the following morning!

But the latter hour did not mean starting before daylight, at that

WHITE-BREASTED CORMORANTS, Santa Marta Island. Straits of Magellan.

season and in that latitude, and the naturalists did not consider that they were making any sacrifices.

The weather during our "midsummer" month in the straits was of all sorts: it was very rainy or misty six days, very windy as many more, slightly snowy two days, really bright and pleasant four days. The remaining days could not well be classified, presenting all of the above-named varieties of weather in such rapid succession that the entries in the log book by each watch included them all, with an occasional fierce squall thrown in to take the kinks out of the cable and give the anchor something to do. The vessel sheered alarmingly as the squalls changed direction, but fortunately they were of only brief

EXPLORING AN ANCIENT SHELL HEAP. Elizabeth Island, Straits of Magellan.

duration. With all these wintry contrarities in the season of summer blooms, it was seldom squally enough to drive the hardy humming birds away from the fuchsias.

Our shore work, beginning at Dungeness Point at the eastern entrance of the straits, covered the territory adjacent to seven different anchorages in the straits proper and six among the channels of western Patagonia, terminating finally at Port Otway, where we entered the South Pacific Ocean. With the exception of Punta Arenas, these points were uninhabited save for the occasional presence of roving canoe Indians.

At Elizabeth Island there were excellent opportunities for the observation of water birds. A rookery of Cassin terns occupied several acres, the nests being close together, so that care was necessary to avoid stepping on them. Eggs and young birds covered the ground and countless thousands of old birds swarmed close overhead, actually clouding the sky, while the noise of their cries was tremendous in volume. The adjacent island of Santa Marta was largely occupied by white-breasted cormorants, the area covered by their nests being several acres in extent. The nests, about six inches high by eighteen in

diameter, were placed close together. The great mass of old birds remained by their nests until cameras could be brought into play at a distance of fifteen or twenty yards. On being approached closer they shuffled off, not taking wing until more closely pressed, leaving the well-grown young behind. The latter had not developed the white breasts of the adults and were quite fearless. Another species of cormorant lacking the white breast, had nests along the low cliffs, while eggs and young of gulls were abundant on some elevations near the water.

Our explorations were not confined to the shores; when the ship was under way, the large dredge, or beam trawl, was often lowered to drag on the bottom, once as deep as 370 fathoms. It was, in fact, dragged systematically through the inland passages of the straits and Smythe Channel from Cape Virgins on the Atlantic to Port Otway on the Pacific. This big iron-framed net, hauled by steam power, brought up fishes, shells, crustaceans, sea urchins, starfishes and many other sea forms whose scientific names are here somewhat out of place.

Among the fishes we often got *Macrurus,* that strange, big-eyed, long-tailed genus distributed nearly everywhere over the ocean floor. Crustaceans were better represented in the dredge hauls, many deep sea types being brought up. Mollusks were plentiful in number and variety, living brachiopods—the "lamp shells" so well known as fossils—appearing frequently.

There were many specimens of small octopus and a couple of burly squids nearly six feet long. The deep-water species were, as a whole, new to science.

This whole region is an anciently depressed, sea-engulfed mass of mountains among which the voyager of the present carefully gropes his way.

The navigation of the straits is confined to daylight work and the summer days are of course long, but even then heavy fogs have to be reckoned on. The short nights were always passed at anchor. While the straits are several miles wide in places, there are dangerous narrows which can only be passed at slack water. English Narrows are less than a quarter of a mile wide and the channel affords room for but one ship at a time.

The only settlement worthy of mention here is Punta Arenas, the most southerly town on the globe. The region is too far south for agriculture, but garden vegetables can be grown in sheltered places. There is some gold digging carried on, but sheep raising has become an established industry. There was much in the climate to remind me of the Aleutian Islands, which lie nearly in the same latitude in the north.

Our observations of water temperature in the straits varied from 47° to 57° Fahrenheit, the higher temperature being found in the

more northerly channels. The temperature of the air followed in a general way that of the water.

While there was a great deal in the way of birds and flowers to suggest familiar objects, our surroundings in other respects were strange. The trees of the forest, the smaller forms of sea shore life, the utterly barbarous look of the natives, the wildness of the scenery, left strong impressions. Even the constellations were altogether unfamiliar. The navigating officer pointed out the Southern Cross, the beautiful nebulous mass called the Cloud of Magellan, the " Coal Sack," that dark starless area close to the Milky Way, and the bright stars Canopus and Achenas.

I know of no more forbidding headland than Cape Froward, the southern point of the continent. The scenery reminds one in many ways of the inland passage of Alaska and is probably finer, as there are more high cliffs of exposed rock. As in Alaska, the vegetation of the forest comes uniformly down to sea level, and here we find it actually overhanging and touching the surface at high tide.

After passing through Magellan Straits and turning northward into Smythe Channel and the series of inland passages beyond, the channels become narrower and the scenery wilder. The evergreen coniferous forests of the north are here replaced by evergreen beeches, which give a new and strange aspect. There are, however, the same high, tumbling waterfalls in the foreground with snow-topped ranges beyond.

No ordinary description can convey a clear idea of the generally impenetrable character of the forests, which are more tangled and difficult than those of the tropics. Fallen trees and branches cover deeply the whole forest floor, these in turn being mostly concealed with mosses and large plants, the whole always saturated as if by a recent rainstorm. After clambering over decayed logs, heavily blanketed with mosses, one may land waist deep in boggy vegetation. Progress is possible only by constant and laborious climbing over obstructions.

In this western section of nearly four hundred miles, the open ocean is seen only once, so completely is the long stretch of coast protected by the lofty islands of the archipelago. Passing gradually northward, glimpses of lofty snow ranges become more frequent, and at the mouth of the last narrow channel the white Andes are exposed to full view and may be enjoyed during the forty-mile voyage across the Gulf of Penas.

Before leaving Eyre Sound we made fast to one of the small icebergs drifting away from adjacent glaciers terminating in tide water, and took on board seven tons of ancient Andean ice for our voyage northward to the Galapagos Islands in the tropical Pacific.

THE FUTURE OF THE HUMAN RACE

By Professor T. D. A. COCKERELL
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EVOLUTION is not an orderly march along a well-defined highway, to the slow time of the music of the spheres. In its details, it is an irregular process, sometimes so slow that millions of years seem to make no difference; sometimes so rapid that a single generation marks a notable advance. Many of its most remarkable products come into existence only to perish shortly afterwards, because they are exclusively adapted to conditions which are not permanent. Rapid progress seems usually to go with a high percentage of failures, as though progress itself were only an attempt to dodge the stroke of doom. Out of all this man, the species *Homo sapiens,* zoologically speaking one of the higher apes, has in these latter days evolved. A creature in many ways inferior to his brother mammalia, but favored by the gods. Denuded of hair, he is obliged to spend much of his time and energy providing artificial clothing; slow of foot, he is compelled to devise means of travel not depending upon his muscular activities; so deficient in the sense of smell, that he does not know, as do the dog and the ant, that it is the most important of all the senses; lacking a tail, and with no grasping power in his feet, he rarely ventures to climb the trees; a poor creature indeed, well-fitted to be the laughing stock of the rest of animal creation.

All this would not be so bad if, like his sylvan ancestors, he could go on his way with a placid sense of his own sufficiency. Alas! even this poor privilege is denied to him; in the Garden of Eden, at the very beginning of his career, he acquired the sense of sin, and was henceforth to be a wanderer in a spiritual as well as a physical sense. Hence it comes that we, in this year 1910, think it proper to enquire anxiously about the future of our species, an inquiry which would certainly never occur to any other species of mammal.

At the very outset we are bound to observe that without exception the species of mammalia are short-lived. The records of the Tertiary rocks show a continually changing panorama of mammalian life, in which genera and species come and go, while plants, mollusca and other lowly organisms remain almost unaltered. We further notice that the comparatively brief existence of these animals may be terminated in either of two ways—by extinction, or by change into something else. When the creatures are very highly developed in special ways, they

seem nearly always destined to die out, being supplanted by the descendants of simpler and more plastic forms. Supposing the career of man to resemble that of other specialized mammalia, he might be expected to have before him perhaps another hundred thousand years, and then in all probability the end of the world, so far as he was concerned with it as an animal. Even on this hypothesis, he would have as much occasion to prepare for his terrestrial future as a young child has for its adult life, but there are very good reasons for supposing that the fate of man need not necessarily be the same as that of the animals to which he is most nearly allied. Prior to the existence of man, living beings might have been divided roughly into two groups, those related to very simple or unchanging environments, such as the amœba or the oyster, and those specially adapted to complex conditions, such as the yucca moth and the giraffe. The former have proved successful through their very simplicity, have been saved by their lack of progress; the latter are nature's masterpieces, often destined, as such things are, to go out of fashion. Any single man may be taken as a rather extreme example of the latter type; he is extraordinarily dependent upon a special set of conditions, but the race as a whole is relatively independent, and without sacrificing anything of its organic complexity, is able to meet and overcome the dangers which have destroyed so many of the higher mammals. If with this man can secure a genuine but moderate progress in his fundamental organism, not sufficient to break the continuity of tradition or destroy his essential specific unity, he may be assured a career such as no mammal ever had before.

The causes of the extinction of other animals have been principally related to climate, food and natural enemies, including here the germs of disease. With regard to climate, man at first, through racial differentiation, became adapted to everything from tropical heat to arctic cold; but here he was on the way to split up into a number of distinct species. Now through devices of housing and clothing he can almost create climatic environments for himself, and so single races, or mixtures of races, are to be found nearly everywhere. At the same time, like the bird, he knows how to migrate when necessary, so that he will never be destroyed by changes confined to a single continent or even hemisphere.

In the case of food, he is relatively unspecialized, and no doubt his omnivorousness has greatly aided his spread over the globe. So long as he had to depend upon the supplies furnished gratis by nature this was a necessary condition of his cosmopolitanism; but now that he can so largely control his food supply, and can carry any given product to the opposite end of the earth, it is a question whether there will not be a distinct gain in a return to primitive simplicity in diet.

Of natural enemies, the grosser and more tangible kind, like the

lion and tiger, have in most places been destroyed; but the small insidious germs or bacteria remain with us. Through a process of natural selection, we have acquired a comparative tolerance of or immunity from several of them, but they have at all times heavily taxed our resources, and have actually been the means of exterminating many races. It is perhaps not unlikely that man would have died out before this, had he been confined to any limited region; but since his distribution has always been wider than the prevalence of any one disease, he has managed to survive in spite of all of them.

A very interesting discussion of the insidious parasites of disease has been given by Dr. Ronald Ross in an address on "Malaria in Greece," delivered before the Oxford Medical Society.[1]

Until recent times, the success of mankind in weathering the dangers of disease has been mainly due to the precautions he has been able to take, along with the limited distribution of diseases, and the process of evolution against them. In the future with the aid of science there can be little doubt that the bacteria of many will be exter-

[1] This is quoted, with much other pertinent matter, by Dr. L. O. Howard in Bulletin 78, Bureau of Entomology, U. S. Department of Agriculture (1909).

We now come face to face with that profoundly interesting subject, the political, economical and historical significance of this great disease. We know that malaria must have existed in Greece ever since the time of Hippocrates, about 400 B.C. What effect has it had on the life of the country? In prehistoric times Greece was certainly peopled by successive waves of Aryan invaders from the north—probably a fair-haired people—who made it what it became, who conquered Persia and Egypt, and who created the sciences, arts and philosophies which we are only developing further to-day. That race reached its climax of development during the time of Pericles. Those great and beautiful valleys were thickly peopled by a civilization which in some ways has not been excelled. Everywhere there were cities, temples, oracles, arts, philosophies and a population vigorous and well trained in arms. Lake Kopais, now almost deserted, was surrounded by towns whose massive works remain to this day. Suddenly, however, a blight fell over all. Was it due to internecine conflict or to foreign conquest? Scarcely; for history shows that war burns and ravages, but does not annihilate. Thebes was thrice destroyed, but thrice rebuilt. Or was it due to some cause, entering furtively and gradually sapping away the energies of the race by attacking the rural population, by slaying the new-born infant, by seizing the rising generation, and especially by killing out the fair-haired descendant of the original settlers, leaving behind chiefly the more immunized and darker children of their captives, won by the sword from Asia and Africa? . . . The whole life of Greece must suffer from this weight, which crushes its rural energies. Where the children suffer so much how can the country create that fresh blood which keeps a nation young? But for a hamlet here and there, those famous valleys are deserted. I saw from a spur of Helicon the sun setting upon Parnassus, Apollo sinking, as he was wont to do, toward his own fane at Delphi, and pouring a flood of light over the great Kopaik Plain. But it seemed that he was the only inhabitant of it. There was nothing there. "Who," said a rich Greek to me, "would think of going to live in such a place as that?" I doubt much whether it is the Turk who has done all this. I think it is very largely the malaria.

minated, and it will no longer be necessary to think of them as possible dangers to human life. Thus, in England, by the universal practise of muzzling the dogs for a sufficiently long period, hydrophobia has been eliminated; in the tropics by the quite feasible if somewhat difficult plan of destroying the mosquitoes, yellow fever and malaria may be utterly stamped out in some regions. Other diseases are much less easily controlled, but it does not appear more difficult to destroy them than it once did to get rid of the wolves in England.

Along with the development of the medical and agricultural sciences, we may hope for great advances in social organization, reducing to a minimum the tremendous waste of life and property which goes on to-day. It is not too much to expect that every individual will be assured all the air, food, clothes and shelter necessary for a normal existence, and will find ample opportunities for exercising such talents as he may possess. Liberty will be curtailed in so far as it permits antisocial activities, but it will be tremendously extended, in the form of practical opportunities to develop ordinary or special abilities. All this may be a long way ahead, and there may exist great differences as to the program for the near future; but I suppose that few will deny that some such outcome as that indicated should logically follow from indefinite advance in the direction we are even now taking.

If we picture human society thus relatively perfected, and free from many of the ills which now so fearfully decimate it, what have we left to desire? Very much, I venture to think. Is there one of us who could honestly say that, if he had been born into such a society, he would be without any serious defects of mind or body? In other words, given as good an environment as could well be devised, should we then be perfect? It is exceedingly obvious that we should not.

Those who are enthusiastic, and very justly, concerning the possibilities of social reform, are somewhat too apt to assume that all deficiencies noted in people to-day are due to adverse external conditions. The student of heredity—even the farmer, when he is dealing with his crops—knows better than that. Figs do not grow on thistles, for all the fertilizers in the country. There is no doubt whatever that every year there are born thousands of persons who are not merely unfitted to succeed in the world as it now is, but would never be successful in any complete sense in any world which could be devised or imagined. Some of those who recognize this fact see in it the doom of all social amelioration. If to-day the tremendous destruction of the unfit which takes place leaves us so many incapables, what would happen if most of those who perish were to survive? Would not society be buried beneath a load of incompetency, which would make even such organization as we have impossible? To this gloomy suggestion it may be replied, in the first place, that much of the present-day elimination is of those who

would be eminently fitted to become useful members of society, could they be saved. Those who die of bacterial diseases may be unfitted to cope with those diseases, but this does not imply all other forms of unfitness. This has been recognized from time immemorial, in the phrase, "those whom the gods love die young."

In the second place, it should be pointed out that while much of the elimination now occurring is desirable, it is no doubt preposterously haphazard, and those who so keenly recognize the need for elimination, should be the first to advocate a rational method of bringing it about. This rational method consists, not in the *destruction,* but in the *prevention* of the unfit.

At this point it will be useful to leave mankind for a while, and consider some of the recent results of the study of heredity; results obtained mainly from investigations on plants and lower animals. Without going into detail, it may be said that through the researches of Mendel, Bateson, de Vries, Davenport and many others, we have come to a very clear recognition of unit-characters in inheritance. That is to say, particular characters, such as hairiness, eye-color or susceptibility to some disease, are inherited separately, passing from one generation to another much as atoms pass without change from one to another chemical compound. These unit characters may be lost, and sometimes the loss is real and final, sometimes it is illusory, due merely to non-potency. In very simple cases, it is found that the inheritance of these units follows easily recognized laws, the distribution being in accordance with the laws of chance. In others, this is not evident, and in man especially, the results are often perplexing. Thus the mulatto is virtually a blend between the white and black races, and at first sight it is not at all apparent that the racial characters are inherited as separate units. Nevertheless, we have indications of this in the remarkable differences sometimes observed within a single family of mulattoes, and it may well be inferred that further investigation will yield results in accordance with recognizable laws, and in so far predicable in advance.[2]

The absolute distinction which at first seems to exist between characters which are inherited as separate units and those which blend may not be real. When the units are obviously separate, but are fairly numerous, they will produce every sort of mosaic, in the most confusing, and at first sight wholly disorderly manner. Let them be somewhat more numerous still and it becomes practically impossible, by mere inspection, to disentangle the result. It is just as black and white balls, if of large size, will appear as separate things when mixed, but if sufficiently small will give an apparent blend, of uniform gray. Because

[2] When two "opposing" units coexist after a cross, there not rarely occurs a blended result, due to what is called "imperfect dominance," but this does not prevent complete segregation in a later generation.

of this possibility, we are not as yet entitled to explain all blending away as illusory; but we may bear in mind that this may be the case. It can at least be said, that scarcely a month passes without some case of inheritance, formerly seeming inscrutable, being brought into the field of well-ascertained law.

With the incoming of the idea of unit characters, passes our former conception of continuous variability. Supposing every character to be at all times variable—that is in motion, as it were, away from its present center of stability—there is no doubt that continuous selection would be required to keep characters up to any particular standard. The extraordinary permanency of some organic characters should suffice to make us doubt this necessity. For millions of years, certain features in the lower animals have been handed down generation after generation, practically without change. When we remember the tremendous complexity of the protoplasm molecule and the much greater complexity of the least imaginable bearer of heredity, and the fact that it has not been possible to break up and then reform the combination, as in inorganic chemistry, the permanency of these units in time is simply amazing. Least particles of protoplasmic jelly, they have stood while the rocks have been ground to dust, and made over many times. They are entitled to be ranked among the most permanent things in nature.

What then of the facts of variability, as they appear to us? What is the use of denying continuous variability, in the face of the fact that no two human beings are alike? The paradox may be resolved, when we remember the extraordinary number of words in the English language, no two the same—yet made up of the undeniably unchanging letters of the alphabet. When we recall that, on the unit character theory, the units in man must be exceedingly numerous, and must be recombined in almost every conceivable way in bisexual inheritance, it is easy to see that the chances against any two individuals coming out exactly the same are so great that such a result is practically impossible. The only case which can come under this head are those of identical twins, where the resemblance is indeed amazing, throwing light on the extraordinary potency of inheritance. Such twins are believed to result from the division of a single fertilized ovum, and hence to be, in a biological sense, two halves of a single individual.

Much light has been thrown on the permanence of unit-characters by studies among plants and protozoan animals of what are called pure lines. A pure line is one in which all the individuals have the same ancestry, uncontaminated by crossing. The most remarkable results have been obtained by Professor Jennings in his studies of *Paramecium*.

He says:

> In a given "pure line" (progeny of a single individual) all detectible variations are due to growth and environmental action, and are not inherited.

Large and small representatives of the pure line produce progeny of the same mean size. The mean size is therefore strictly hereditary throughout the pure line, and it depends, not on the accidental individual dimensions of the particular progenitor, but on the fundamental characteristics of the pure line in question.

All this indicates that if desirable qualities, represented by units in inheritance, are once obtained, and are not disturbed by crossing, they may continue from generation to generation indefinitely, without variation other than that produced in the individual by the immediate influence of the environment.

But, here, as Professor Jennings remarks, we have to ask how the different pure lines arise? That is to say, whence the different qualities which assuredly did not all coexist in the original form of life? We have seen that the unit in inheritance is, to say the least, a very complex object from a chemical point of view. No doubt it is easily destroyed, but its usual character seems to be that of resisting molecular change short of disintegration. Thus it is carried on from individual to individual, virtually unaltered, or in the alternative cases, destroyed. Occasionally, however, it must be subjected to some subtle influence which merely disturbs its internal structure, or perhaps deprives it of something it possessed. When this occurs, we have an original variation, the starting of something really new. Such original variations must be relatively rare, and we do not know what causes usually bring them about. Tower with beetles and MacDougal with plants seem to have produced them, in the one case by changes of temperature and moisture, in the other by chemical means. The fact that in some regions certain genera produce many species, as the asters in America, the brambles in Europe, seems to suggest that the disturbing influence may be different for different organisms, and may be locally distributed. Or it may be that, a line of disturbance once set up in some unknown manner, influences prevalent anywhere are sufficient to continue the line of change.

It may be that coming generations will see the causes of original variation fully elucidated, and the phenomenon itself brought largely under control. While mankind would thus be furnished with a weapon of extraordinary value, one trembles to think of the damage it might do. It might be made the means of producing new and wonderful variations in plants and animals, even in man himself; but inasmuch as there is every reason to suppose that its results could not often be accurately foretold, there is no telling what evil might result, even supposing that the power was never used with intentionally malicious purpose.

We are not at present, however, in any danger of being overrun with original variations; and it must be remembered that most of the recent wonders of Burbank and others, which are new in a practical

sense, owe their origin biologically to recombinations of characters which have existed from time immemorial in separate races. No doubt the great men which arise in human societies from time to time may be explained in the same manner, so far as they are regarded as biological phenomena.

This possibility of producing what is virtually new by recombination must now be considered. Through the work done by various breeders, beginning with Mendel, we know much about the manner of such combinations, and how to get rid of undesirable units. Where the cases have been simple almost ideal success has been attained: and in complicated cases it has been possible to produce definite results by concentrating attention on special characters. Thus Bateson in his presidential address before the zoological section of the British Association in 1904, said:

> There are others who look to the science of heredity with a loftier aspiration: who ask, can any of this be used to help those who come after us to be better than we are—healthier, wiser or more worthy? The answer depends on the meaning of the question. On the one hand, it is certain that a competent breeder, endowed with full powers, by the aid even of our present knowledge, could in a few generations breed out several of the morbid diatheses. As we have got rid of rabies and pleuro-pneumonia, so we could exterminate the simpler vices. Voltaire's cry, "Erraser l'infâme," might well replace Archbishop Parker's "Table of Forbidden Degrees," which is all the instruction Parliament has so far provided. Similarly, a race may conceivably be bred true to some physical and intellectual characters considered good.

We come then to the conclusion that in the case of man, as with domesticated animals and cultivated plants, it is possible to get rid of many undesirable qualities, to combine others which are desirable, and to maintain indefinitely that which has been once secured. Where there is bisexual inheritance we can not have strictly pure lines, to be sure, but it is possible to have lines which are pure within practical limits. That is to say, we may have a race of people none of whom have a certain hereditary taint, all of whom have a certain hereditary quality. Beyond this, we would not go, were it possible; for no one would wish to sacrifice the interesting diversity of human types which makes life chiefly worth while. In our national aspirations, we have recognized the ideal of a moderate unity of type; thus all Englishmen will agree that a true, full-blooded countryman of theirs should possess certain attributes, and will admit that those who fail in this are not strictly of the elect. All Frenchmen, typically, should have a certain vivacity not found among the Englishmen, and so on throughout the series.

Thus the ideal of a relatively pure race of high quality is by no means a new one; but what is new is the practical knowledge of how this may be brought about, with the certain expectation of much more

light on the subject in the near future. The realization of such an ideal involves selective mating; but this again is nothing new, all mating among civilized people is selective, with a wide range of reasons for the selection. To these will now be added a new one, or rather an old one in a somewhat new light.

Professor J. Arthur Thomson well says:

> As to the diffusion of disease by the intermarriage of badly tainted with relatively healthy families, we have this in our own hands, and we need not whine over it. The basis of preferential mating is not unalterable, in fact we know that it sways hither and thither from age to age. Possible marriages are every day prohibited or refrained from for the absurdest of reasons: there is no reason why they should not be prohibited or refrained from for the best of reasons—the welfare of our race.

On the other hand, we have to consider the means of increasing and continuing good qualities. The economic burden of raising a family is at present such as to discourage many whose qualities should be continued to other generations, and there can be no doubt that it would pay society to furnish ample means for the industry of child raising to those who are especially fitted to engage in it. Mr. Francis Galton has tried to calculate the value of different classes of individuals:

> The worth of a $+\times$-class baby would be reckoned in thousands of pounds. Some such "talented" folk fail, but most succeed, and may succeed greatly. They found industries, establish vast undertakings, increase the wealth of multitudes, and amass large fortunes for themselves. Others, whether they be rich or poor, are the guides and lights of the nation, raising its tone, enlighting its difficulties, and improving its ideals. The great gain that England received through the immigration of the Huguenots would be insignificant to what she would derive from an annual addition of a few hundred children of the classes $+w$ and $+x$.

MIDDLE AND DISTANCE RUNNING

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IS middle and distance running as practised in our schools and colleges injurious or is it not? The verdict of spectators at an intercollegiate or interscholastic track meet, as the contestants cross the finish line frequently exhibiting every evidence of exhaustion, would probably be in the affirmative. It is difficult for them to resist the belief that a contest which so drains a man of his strength must, of necessity, use up vitality that can never be completely restored, must permanently weaken the heart, and perhaps injuriously affect him in other respects. This investigation was undertaken in the hope of ascertaining whether there is adequate foundation for such a belief.

In an experience extending over fifteen years, the writer has attended many track meets, has known personally hundreds of runners, has time and again questioned them in regard to their personal experience. Curiously enough, he has never found a single man who would admit that he had been injured by racing. The incompatibility between the positive assertions of these men and the popular impression as to the effects of distance running was so pronounced, and the subject is such an important one in its relation to schoolboys and college men, that an investigation became imperative. The investigation does not deal with the marathon running of the present day, but solely with the distances usually run in school and college—one half to two miles and cross-country seven miles.

Athletes from all parts of the country have been consulted, principally men who quit running years ago, and who have had ample time to note in their own persons the after effects of the training they underwent; men whose youthful enthusiasm has been sobered by years of business or professional life and whose judgment is therefore to be respected. Some of them quit running thirty years ago; others twenty-six, twenty-four, eighteen, twelve, etc. A few are still running, only eight in all. Seven have just quit, nine stopped a year ago and the great majority from two to thirty years ago, averaging eight and a half years. Nearly one half of the whole number ran for five or more years, training five to six days a week in two groups, one group averaging twenty-six weeks a year, the other ten weeks. Many trained six days a week, thirty to forty weeks a year. These men have been allowed to speak for themselves, first as to

facts, *i. e.,* the manner in which they have been affected by their running; second as to their opinions, *i. e.,* whether or not they consider distance racing and cross-country running safe and valuable forms of exercise. The facts to which they testify must be considered as final; the opinions they express, even if not accepted as conclusive, must be of greater value than opinions based merely upon theory, for they are the incarnation of living experience, formed through days, weeks and months of hard grueling work, through knowledge of the manner in which their team mates bore the drudgery of training and the strain of contest, and shaped finally by their own physical condition during the years which have elapsed since they ran.

Injuries to the Heart.—In view of the general belief that running is apt to injure the heart, particular attention was given to this phase of the question. Contrary to expectation, permanent injury to the heart was found to be very rare, only three men testifying to this effect and in these three cases the injury manifests itself only in unusual exertion. Twelve others developed functional heart affections, irregularity, palpitation, etc. Further correspondence with these men shows that all of these functional irregularities have been entirely cured. Ten of these fifteen men had what is known as "athlete's heart," three of the cases persisting to this day, as stated above.

Generally speaking, the term "athlete's heart" is very vaguely comprehended. In medicine, it is defined as compensatory cardiac hypertrophy—that is to say, it defines a heart which although it has become enlarged, still performs its functions perfectly. Such a heart is normal in an athlete or in any man who performs vigorous physical exercise, the fibers growing firmer and larger as the demands upon the organ increase, just as a man's muscles grow firmer and larger under a month's outing in the woods. In almost every instance a heart of this type will shrink to approximately its former size without injury to its tissues, after the exercise has been discontinued. When, however, a man pushes his exercise too far, his heart may develop valvular insufficiency, palpitation or other functional irregularity, and I am inclined to believe that this is what the average physician means when he tells a man that he has "athlete's heart." This was so in most of the cases mentioned above, nevertheless, all but three of the men have since been cured. "Athlete's heart" is usually a temporary condition and permanent injury from overwork is rarely found. In an experience with school boys in all branches of athletics extending over a period of fifteen years, I have met with but one case of true athlete's heart, and this boy's physician told him that if he would abstain from violent exercise for six months he would be entirely cured. This heart affection was brought about by two years of hard training for the mile, beginning at an early age. This case, together with the free expression of opinion from athletes to

whom this inquiry was addressed, strengthens my conviction that unless a boy is unusually well developed, he should not take up distance running in earnest until eighteen years of age, and leads me to believe, furthermore, that the practise of running school boys daily from the beginning of the school year in order that they may compete in the spring, is a bad one, as is also that of running them in so many races during the season.

But there was found to be a credit as well as a debit side in the effects of running upon the heart. One man writes: "My training and running caused previous heart and lung trouble to disappear"; another, "transformed a nervous heart into a normal one"; another, "transformed a heart beating 100 usually, with occasional palpitation, into a normal one and caused the palpitation to disappear"; another, "when I began running, I was so weak that I was supposed to go down stairs backward—at the last physical examination I was found to have one of the best hearts in the school. Ran four years from 440 yards up to seven miles."

Other Injuries.—In response to the question "Has racing ever injuriously affected you, and how?" eight men testify to temporary injury due to over training or to racing when in poor condition, such as weak stomach, run-down condition, nervous breakdown, etc., the bad effects lasting from several weeks to as long as twelve months in one instance. One of these men ran the half mile, mile and two miles in one afternoon several times each year of his course of four years. This, of course, was simply inviting disaster, and it is difficult to understand how any college trainer could have permitted it. This brings us directly to a statement by one of the most famous athletes this country has ever produced, namely that

> The great trouble in my opinion is the lack of knowledge on the part of trainers. The tendency is to overdo. This is particularly true of the school boy who imagines that unless he runs himself clean out every day of practise, he is not getting in the proper condition for competition. This is where he makes a mistake, and where, in my mind, he is going to feel the effects in later years.

Proper training means work suited to the strength and development of the individual, and if a man is so trained, is allowed to compete only when fit, and is fit to run when he begins training, such injuries would not occur.

Benefits.—In answer to the question, "Has it benefited you in any way?" ninety per cent. answer "Yes," five per cent. do not know whether it has or not, and five per cent. reply, "It has not." The benefits said to have resulted are in general, strengthened heart and lungs, developed a rugged constitution, cured several weak hearts, "gave perfect health and endurance very beneficial in recent years," "cured frequent headaches," "effected a complete emancipation from

doctors and medicines," etc., and the relatively minor one of increased muscular development. The usual benefits resulting from training for any branch of athletics are also emphasized, namely, regular hours and regular habits of living, how and what to eat, the incompatability of dissipation with physical stamina, the moral lesson that hard work, and that alone, leads to success. These benefits, it will be noticed, are of the kind that contribute to increased constitutional strength, strength of heart, lungs and vital organs, and are permanent in character. The almost unanimous testimony to this increase in vital strength is worthy of special note.

Cross-country Running.—Cross-country running is generally believed to be one of the best exercises that young men can take. The testimony of Mr. Joseph Wood, the headmaster of Harrow, is of particular value in this connection. He writes:

> We keep no actual record of our runners, but I have been a headmaster now for over forty years, and my experience certainly goes to prove that cross-country running does no harm but much good; second, that in long-distance racing much care is necessary. No boy should be allowed to compete unless certified as sound and fit by competent medical advisers. At Harrow we make this a rule.

As Mr. Wood implies, there is a vast difference between cross-country running, in which a man swings along at a rate well within his powers, and cross-country racing, in which he must drive himself at high pressure from three to ten miles. There seems to be a pretty well-developed opinion among the runners that cross-country racing is injurious. An intercollegiate champion, the captain of a varsity team writes:

> I have had considerable opportunity to observe the effect of track and cross-country racing on athletes in this section [the west[. I have yet to see the track man at ——— who was injured by races over the half-mile, mile and two-mile courses, but cases have occasionally come to my notice of men whose vitality was drained severely by cross-country races over five-mile courses.

Another captain and coach writes to the same effect. Information accidentally received relating to one of the eastern universities, reveals a belief among the students that the men on the cross-country squad drain themselves of vitality, and there is frequent expression of opinion to that effect from the athletes who responded to this inquiry.

Interesting Facts.—The cross-country men began running later in life than the track men, the average being 18½ years, as compared with 17½ for two milers, 17 for milers and 16 for half milers. In the latter, the percentage of heart affections was greater than with the one and two mile men. In view of the immaturity of the boys who ran in the 880 class, this is not surprising.

Two thirds of the athletes participated freely in general athletics when not in training for track—in football, baseball, basketball, tennis, hockey, gymnastics, etc., and were practically engaged in vigorous ex-

ercise for a period of five and a half years. Their statistics do not show appreciable variation from those of the one third who engaged in running only.

Naturally and yet unexpectedly the men who trained on an average of about ten weeks a year, nothwithstanding they numbered less than two fifths of the whole number, had nearly twice the percentage of injuries. In attempting to fit themselves for the strain of a distance race in such a short time, they overworked, with consequent bad effects. Curiously enough, the men who trained twenty-six weeks a year and continued running from seven to twelve or fifteen years, had no injuries at all. It might be supposed that this vigorous exercise continued for such a long time would drain their vitality. Exactly the contrary has been the case. With one exception, all claim to be more vigorous than the average man of their age, and the exception declares himself fully as vigorous.

One half of the athletes began running as schoolboys, and 78.5 per cent. made good in college, as compared with 75 per cent. of those who did not take up the sport until they entered college. Twice as many of the boys who ran only a year or two in school made good, as of those who ran three or four years. This seems to indicate that boys who begin at school, if they do not begin too young, and if they are brought along gradually, learning stride and pace and developing stamina, have a slightly better chance than even the more mature man who takes up the sport after he enters college. There is nothing surprising in this, as it requires several years to bring a distance runner to his best. C. H. Kilpatrick, winner of the American and Canadian championships, '94, '95 and '96, and until recently holder of the world's record for the half mile, began running while at school, as did also George Orton, intercollegiate mile champion for several years. Melvin Sheppard before becoming an Olympic champion was famous throughout the middle Atlantic states as a school-boy runner. It is a common saying, however, that school-boy stars usually "fall down" in college and unquestionably many runners of promise are spoiled before they get there, but, generally speaking, the school-boy star fails to develop into a college star because he has stepped from the narrow limits of school competition into the much greater range of college athletics. I am inclined to believe that unless he has been overrun, he equals in college his school records and usually surpasses them, and while the data to support it are not at hand, I should expect this to be particularly true of distance running, at which a man should get better and better the longer he keeps at it. The evidence shows, furthermore, that boys who were over sixteen years of age when they began running did twice as well after they entered college as boys who began under sixteen. Evidently the boy who begins too young is throwing away his chances in college.

Breaking Training.—One hundred and twelve athletes quit running abruptly, and all but one of them are in vigorous health to-day, apparently having experienced no ill effects, either from breaking training suddenly or from that overdevelopment of heart and lungs which is supposed to result from athletics. This seems to indicate, first, that unnecessary emphasis has been laid upon breaking training gradually and, second, that abnormal development of the heart and lungs leading to serious affections of these organs is not to be feared.

The entire physical organism is developed by training to a condition of unusual efficiency in order to meet the demands made upon it. It is generally believed that when these demands cease suddenly —through abruptly breaking training—tissue degeneration follows, inducing physical ailments of greater or less severity. There is, undoubtedly, an alteration in the tissues when the organism is no longer called upon for vigorous activity, but the theory that this change is a pathological one is not sustained by the facts, in so far at least as distance runners are concerned, save when it is aggravated by bad habits, dissipation or close confinement. It has not been sustained in my experience with school-boy athletes, for in fifteen years I can recall but two cases of indisposition after the season, both temporary, both in football men, big and full blooded, of the type that require an active life. I think it is not sustained by the experience of the vast majority of athletes graduated from our colleges year by year, who from choice or necessity engage in business activities which deny leisure for indulgence in sport, for, if so, it should by this time show negatively in the national health statistics, whereas, on the contrary, the spread of athletics in the past generation is believed to have raised the standard of national physical efficiency. It seems to me likely that the ordinary activities of life are sufficient to bridge over the transition period, especially as men who have been accustomed to a great deal of exercise, and who feel the need of it, will, as a rule, manage to get more or less of it into or in connection with their work. I am of the opinion that, save in rare instances, the development produced by college athletics is not abnormal—as is that of professional strong men, weight lifters, acrobats, etc., in whom vitality is sacrificed to muscular development—but that it is normal, and constitutional as distinguished from muscular development, for none of the college sports, except perhaps the hammer throw, develop great muscular strength. The character of the athlete's training supports this belief. He trains hard for a season or two (twelve to thirty weeks), but during the intermittent periods and the summer his exercise is much less severe, and is engaged in solely for pleasure. He works during the training season and plays in between, the mid-seasons in this way providing just the type of letting down that is supposed to be neces-

sary, so that at the close of his college career, instead of cumulative abnormal development, as in the case of the professional strong man, he has built up an evenly-balanced physical machine.

Expert Opinions.—The athletes are nearly unanimous in endorsing cross-country running (as distinguished from cross-country racing), as a safe and valuable form of exercise, but the same unanimity is not shown when we come to the consideration of distance racing—880 yards to two miles. Ten per cent. of the men oppose racing of any kind, on the ground that it involves too much strain. Eighty per cent. of them approve it, nearly one third of these, however, qualifying their approval by saying, "if not overdone, if under proper training, if sound at the start, if sufficiently mature, etc." These various qualifications, insisted upon by so many of the athletes, indicate a pretty general feeling by men who know the game, a feeling arising from their own personal experience or through observation of others, that distance racing is not free from risk except under competent supervision. Their letters indicate that without such supervision immature boys, and men physically and constitutionally weak, will take up the game; that they, as well as those who are fit to run, will train improperly and will be likely to overdo it. They insist upon a preliminary examination by a competent physician; they are opposed to the practise of running more than one hard race on the same day, a practise common among school boys, who, as a rule, have no competent trainer to advise them; they are opposed to boys taking up the game until they are seventeen or eighteen years of age, although recognizing the difficulty of setting any fixed age limit, since the strength and development of an individual must determine his fitness. Many believe that one mile should be the limit for schoolboy contests. There is a very pronounced feeling among them that school-boys generally overwork. These opinions, held by men who know, can not be disregarded in an effort to discover and set forth the facts. They point to the dangers which lie in the path of the inexperienced athlete, and which bring adverse criticism upon the sport. And yet, notwithstanding these dangers, all avoidable, it will be apparent to any one who reads their letters that they approve the sport if properly supervised, considering it in that case not only safe but of great benefit. Almost all of the men, even those who are opposed to racing, even those who sustained injury while at it, claim to have been benefited by their athletic experience. This can mean but one thing, namely, as one of them expresses it, "the increased health and vigor resulting from training more than compensated for any injury due to racing." The exceedingly small number of permanent injuries revealed by this investigation, and the vigorous health enjoyed to-day by the athletes almost without exception, sustain this view especially since it must be borne in mind that a large proportion of the men quit running years ago, before the

highly specialized trainer of to-day was developed, and consequently must have trained under more or less imperfect methods. It should also be remembered that unlike football and crew men, runners are not select specimens of physical manhood, picked because of their strength and vigor. On the contrary, track men are fragile in comparison. Strip a group of football and crew candidates and place them side by side with a group of track men and no one could fail to be impressed by the contrast in strength and development.

Vitality.—Whether distance running drains vitality or not can not be demonstrated in terms of percentage, as one may speak of the number of bodily injuries or of functional heart derangements. A conclusion must be reached deductively, if at all, from the statistics given by the men; the character of the injuries they have received; the nature of the benefits which accrued from their running; the probable effect of these injuries and benefits on their vital organs; the state of their health at the present time, etc. Vitality must be determined by the condition of the blood, and of the organs which maintain life, the heart, lungs, stomach, kidneys, etc. If running has resulted in strengthening the heart and lungs of these athletes, in improving their digestion, in stimulating to greater efficiency the functioning of their vital organs, in endowing them with greater physical vigor, it has evidently given them greater vitality, greater resistance to disease; if, on the other hand, it has injured their hearts, weakened their lungs, injuriously affected their vital organs; if a fair percentage of them have become broken down athletes, it has impaired their physical vigor and drained vitality. Every one admits the value of running *per se*. It is generally recognized as the exercise *par excellence* which develops vital strength, strength of heart and lungs, the kind of strength that carries a man to a green old age. No one of our athletic teams regularly presents to the eye such evidence of perfect physical condition as does the track team. The practical value from a physiological point of view of all the school and college sports is in direct ratio to the amount of running involved. Racing in itself may be injurious, ten per cent. of the men believe it is, although their letters show that half of these are opposed to it, not because of definite and positive injury known to result from it, but from the vague general feeling referred to on the first page of this inquiry, namely, the belief that it is too great a strain. And this investigation shows that certain injuries do result from it, though much less serious than is generally believed. On the other hand, a large majority of the men deny that racing is necessarily injurious, affirming that injury when incurred is caused by poor condition, and that if a man is fit when he toes the mark, he is not likely to injure himself, no matter how hard he runs. But it is impossible to consider racing alone, since running is inseparably connected with it. Boys can not race without training, and will not

train without racing. There seems to be no doubt in the minds of the athletes themselves as to the effects of their running. Over ninety per cent. claim to have derived permanent benefits, in many instances of inestimable value, and only four of the entire number testify to permanent injury. Some of the letters have a direct bearing on the subject of vitality, others relate to it indirectly; one man writes:

> Cornell University is distinguished above all other institutions for the development of runners at the distances you mention. I am in touch with all the 'varsity distance men graduated in the last ten years, and there is not a case of physical debility in the whole lot. Most of them are much more alive than the average man.

A famous distance runner whose feats astonished men a few years ago, writes:

> I have been running for over twenty-three years now, and feel in perfect physical condition. Have won races from seventy-five yards up, and have run over one hundred miles quite often. My heart has been examined by specialists in London, Paris, Boston and other places, and all say that it is in perfect working shape.

Another writes:

> My father, who is sixty-two years of age, and an old distance runner, can now run a quarter mile consistently under sixty seconds. He has not been ill since he was a young man, and is as hale and hearty as a man of thirty.

A quarter mile in sixty seconds is beyond the ability of ninety-nine out of a hundred men whom you and I meet in the streets. The average boy of eighteen years can not do it, but the trained runner can with ease. A form of exercise which develops and maintains in a man sixty-two years of age vigor enough to perform a feat beyond the strength of the average man of half his years and which brings forth testimony such as I have just quoted, has strong claims to favorable consideration.

The Jinrickisha Man.—As bearing upon the general subject of distance running, I have endeavored to ascertain how the jinrickisha men of Japan and the dak or post runners of India have been affected by their arduous occupations. Although the work performed by the jinrickisha man differs widely in character from that demanded by the college athlete training for distance racing, there is a parallel if not similar demand upon the heart and lungs, and the effect should be similar in character, differing only in degree. The jinrickisha man performs infinitely harder work than the college athlete. Twenty, forty and even sixty miles a day is no unusual performance, and while he does not run as fast as the college man, he adds to the burden of his running—which ordinarily is hardly more than a fast jog—the strain of drawing a heavy weight, so that in all probability the cumulative effect upon the vital organs is not only equal to but much beyond that of the college man. In addition to this, he is subjected to all

kinds of temperature—drenched in perspiration one hour, shivering with cold the next, hauling his 'rickshaw in all kinds of weather, inadequately fed, smokes and dissipates. His activities are irregular—he may have work several days in succession, then lie idle for as many more, to be suddenly called upon for a renewed strenuous task—and in general his mode of life is exactly opposite to that of the college athlete, who is required to keep regular hours, fed the most nourishing foods, forbidden tobacco and spirits, is bathed, massaged and runs for fixed periods of time, gradually increasing his performances under the careful eye of an experienced coach. It is extremely difficult to obtain definite information concerning the jinrickisha man. No traveler whose works I have read has been sufficiently interested to publish ininformation of the kind that would be valuable in connection with our inquiry. At the most, but casual reference is made to him as one of the picturesque features of the flowery kingdom. Mr. E. G. Babbitt, American vice consul-general in charge at Yokohama, has been good enough to answer my inquiry, and his letter throws more light upon the subject than I have been able to obtain from any other source. He writes:

> The imperial government publishes annually an elaborate report (statistics) concerning movements of the population, but the number of deaths, etc., are given by "age" and not by "occupation," and it would be a very difficult matter to find the death rate among any particular class. Each prefecture has its own laws and regulations concerning the jinrickisha men and in one of the prefectures the age of the applicants for the jinrickisha's man's license has been limited to fifty-five; in Tokio, this age limit came into force in 1907, at which time it was reported that there were over twelve hundred jinrickisha men over fifty-five years of age. Most of these men were healthy and strong. During the year 1907–1908, this consulate-general had two old janitors, both of whom were jinrickisha men over twenty-five years, they said. The superintendent of police of this district whom I interviewed on this subject attributes a comparatively high death rate among them to their irregular diet and excessive use of liquors, to which vice they appear to be more addicted than any other class of laborers.

Dak and Kahar Runners.—In attempting to investigate the dak or post runner of India, I came into possession, through the courtesy of Mr. G. Lockwood Kipling, of information of especial interest concerning the Kahar caste, also known as Jhinwars in the Punjaub. Mr. Kipling writes that this caste "has for many centuries been village servants, appointed to be carriers, runners, watermen, fishermen, basket makers, water fowl catchers, etc.," and are trained runners from generation to generation. Mr. T. C. Lewis, late director of public instruction, United Province, India, in enclosing to Mr. Kipling the story which follows, writes:

> This goes to show that the Kahars who are in a manner born to the work, and are trained to it from their youth up, can, if they do it regularly (the

oftener the better, as the old man said), cover extraordinary distances and without dropping out of the running at an early age as folks seem to fancy.

Mr. John Harvey, formerly assistant inspector of schools, Lahore Circle, who has had abundant opportunity for observation, writes that these people are not short lived and that they are known to have performed "most extraordinary feats of endurance, such as bearing palanquins and doolies, in carrying bangi loads and in long distance running when laying a palki dak, *i. e.*, arranging for a succession of bearers for an urgent palanquin journey." He says:

I know that Kahars live to be old men, for it is from their own lips that I have heard of feats of long distance running, as sarbarais and proved them to be true. I could give you several instances of incredible endurance.

The following story from Mr. Harvey illustrates the wonderful endurance of the Kahar:

LONG DISTANCE RUNNING (DIALOGUE)

SCENE—Amritsar, N. India. Circ. 1875. Time, 5 P.M.

Dramatis Personæ

J. Harvey	Asst. Inspt. Schools,	Lahore Circle.
Maghi Ram.	Doolie chaudhri,	Amritsar.
Gangu	Son of above.	

J. H. "Ah, chaudhri ji! It is necessary that I should have a doolie to start for Sialkot at 8 this evening."

M. R. "Very good, nourisher of the poor, here is the Order book: please write the order and pay the money Rs 30, at the rate of 4½ annas per bearer for six bearers, 1 sarbarai (forerunner) and 1 misalchi (torchbearer) for each of eleven stages, with Rs 5 for the doolie and the balance for oil."

J. H. "There, count the money—is it all right?"

M. R. "Quite correct, noble presence—Take the Rs 20, and be off with you. The doolie will be here at 7:30, Sahib. Salaam."

J. H. "Stay, chaudhri—That Gangu is your son, I think; now will he go the whole distance to Sialkot (64 miles) before morning, laying my doolie dak and paying the bearers?"

M. R. "O yes, noble presence, why not? That is nothing for a boy of his age (20 years). But *kahars* (doolie-bearer caste) are no longer in condition since the railways came in, though their time was always surer."

J. H. "Nonsense. But it is interesting to know that Gangu will do his 64 miles in 9 hours, if he really does do so. How shall I prove it?"

M. R. "Why, nourisher of the poor, Gangu will pay his respects to you, in duty bound, when you arrive in Sialkot, for he must return to me at once with your assurance that all went well on the journey."

J. H. "Well, I know this is said to be the usual procedure, but is it not a trying piece of work for a young man, especially if he has to do it often?"

M. R. "Great king, the oftener the better; for it is much more trying if undergone only occasionally, though we kahars are in a manner born to the work. Unburdened, we could go on forever, but burdened—well, fifty miles is nothing out of the way for a man in practise. Some of your own bearers will not change for three, four, five or more stages on the way to Sialkot. It will all depend on what men are obtainable on short notice. [This was subsequently verified by J. H. who found one man of his bearers toiling under the doolie into Sialkot who started under it from Amritsar and who proved that

he had the previous day reached Amritsar from Sialkot with a banghy (bamboo shoulder pole with burdens at either end) load of mangoes.] My grandfather was a famous long-distance kahar, and my father, an old man now, still carries his banghy all day."

J. H. "Is it so? But now, listen; how far could your Gangu go without rest on one stretch?"

M. R. "Noble presence, there is no telling how far an unburdened kahar could not go, but Gangu should be able to do one hundred miles without food or rest."

J. H. (cynically) "Ah, indeed! And you, I think, in your day could have done two hundred."

M. R. "Great king, O more than that. Listen, incarnation of justice. Just at the mutiny time, Capt. ——— of Mian Mir sent for doolie chaudhri Tika Ram, and after informing him that he had important despatches for Meerut, asked him if he could arrange for a doolie dak there. I need not tell you the distance, Sahib, three hundred miles as the crow flies—and have him carried with safety. Tika Ram was aghast at the very notion, but when Capt. ——— said he had thought of every other means, and had come to the conclusion that a continuous doolie journey through Patiala and Karnal would be speediest, that not only would the chaudri be well paid, but that the reward would be great if the dispatches could be delivered on the third day, and that if Tika Ram, son of Lalu Ram, could not manage it, no one else could, the chaudhri after considerable thought agreed to undertake it, as it was worth risking. So asking for the bare fare in advance, and stipulating for ten hours start for the sarbarai, he despatched his own son on the business of laying a cross-country doolie dak to Meerut. At the appointed hour, the doolie was at Captain ———'s door and bore him off to arrive without let or hindrance at Meerut on the third day, to be greeted on his arrival by the sarbarai, and to give him assurance that all was well."

J. H. "Enough, enough, chaudhri, that will do. Go."

M. R. "Your noble presence does not believe me. Here is the proof, always carried with me. There, great king, cast your eye over that. What is its purport, O mine of intelligence?"

J. H. (Reading No. 1.) *This to certify* that chaudhri Tika Ram, son of Lalu Ram arranged a doolie dak for me from Mean-Mir to Meerut and that he fulfilled his engagement by having me safely brought with important despatches to my destination.

Signed ————————, *Capt. Mianmir.*

Dated ————————.

No. 2. The bearer of this chaudhri Tika Ram, son of Lalu Ram, has been rewarded with the sum of Rs 1000 for etc., etc.

Signed ————————, *General Commander Mianmir.*

Dated ————————.

No. 3. This is to certify that Maghi Ram, son of Tika Ram, doolie Chaudhri of Mianmir, laid my doolie dak successfully from Mian-Mir to Meerut, etc.

Signed ————————, *Capt. Mianmir.*

Dated ————————.

Looking at the chaudhri—"Humph! I am to believe then that you are the same sarbarai that laid the dak from Mianmir to Meerut which arrived on the third day."

M. R. "Incarnation of justice, your slave is the grandson of Lalu Ram, the son of Tika Ram, and the father of Gangu—Salaam."

Exit.

When one recalls the distances covered in the six-day go-as-you-please contests in vogue in this country some years ago, there is nothing incredible in this. If men of this day can average over a hundred miles a day for six days, what is there incredible in one of a race trained from childhood covering three hundred miles in three days? The interesting fact, in view of the scope of this article, is that the Kahars, trained from childhood to be distance runners, lived to be old men; that they were not only able to stand the strain of running great distances under a heavy load, but thrived under it.

I remember years ago of hearing that the post runners of India died at about the age of forty as a result of their exertions, but I have been unable to find any foundation for such a statement. Positive information in regard to the mortality of Indian post runners is unavailable, as they are relatively very few in number and of inferior caste, so that they are not mentioned as a caste in health statistics. Mr. John Cornwall, late postmaster general in the United Provinces, India, writes, that the Indian mail runners cover fifteen to eighteen miles a day, that there is never any difficulty in getting men to undertake the duties and that he never heard of them succumbing at the early age of forty. The rumor may, he says, have arisen from "the arrangement that Sowcars (bankers or money dealers) and Bunyas (merchants and traders) made in pre-mutiny days, to obtain early information as to the markets, rates of exchange, etc. They employed private persons, trained runners, to outstrip the regular mail carriers and convey information up country from trade centers. It was no uncommon thing, fifty years ago to see these messengers "arriving with messages sealed up in quills, and with their leg sinews swollen and strained from their exertions," but there is no definite and authoritative statement that their lives were shortened by their work.

Conclusions.—It seems to be an open question whether cross-country racing is safe for any but men of exceptional strength with the probabilities in the negative. It is evident that distance racing of any kind is attended with a certain amount of risk, which, however, can be reduced to a minimum by proper training. There is nothing in the testimony given by the athletes to show that distance running depletes vitality. As a matter of fact the presumptive weight of evidence is to the contrary. The facts revealed concerning the jinrickisha men and the Kahar runner emphasize this conclusion. If, notwithstanding his irregular diet, excessive use of liquors, exposure to the elements, etc., the jinrickisha man can live to a reasonable age; if, as shown by Mr. Harvey's testimony, Kahar runners live to be old men notwithstanding their extraordinary feats of endurance, we may safely conclude that the infinitely milder work of the college man, usually done under the best conditions, is not likely to injure him, and the evidence at hand appears to establish this beyond reasonable doubt. But the number of injuries

shown, even though nearly all of them were temporary ones, indicate the need for better supervision. None worthy of the name is given the school-boy athlete, except in comparatively few preparatory schools and city high schools. Competent trainers are scarce, but medical supervision can readily be had. If the boys were required to pass a preliminary examination by a competent physician and were examined thereafter at intervals of three or four weeks to ascertain how they are standing up under the training, liability to injury would be practically eliminated.

Twenty-two of the sixty or seventy colleges and large preparatory schools to which we wrote furnished lists of their athletes. These lists contained the names of two hundred and sixty men, two thirds of whom responded to our letters. The replies are so similar in tone and so emphatic as regards essentials that I believe the results shown will be confirmed by further investigation involving any number of athletes.

THE SYMBOLISM OF DREAMS

By HAVELOCK ELLIS

THE dramatization of subjective elements of the personality, which contributes so largely to render our dreams vivid and interesting, rests on that dissociation, or falling apart of the constituent groups of psychic centers, which is so fundamental a fact of dream-life. That is to say, that the usually coherent elements of our mental life are split up, and some of them—often, it is curious to note, precisely those which are at that very moment the most prominent and poignant—are reconstituted into what seems to us an outside and objective world, of which we are the interested or the merely curious spectators, but in neither case realize that we are ourselves the origin of.

An elementary source of this tendency to objectivation is to be found in the automatic impulse towards symbolism, by which all sorts of feelings experienced by the dreamer become transformed into concrete visible images. When objectivation is thus attained dissociation may be said to be secondary. So far indeed as I am able to dissect the dream-process, the tendency to symbolism seems nearly always to precede the dissociation in consciousness, though it may well be that the dissociation of the mental elements is a necessary subconscious condition for the symbolism.

Sensory symbolism rests on a very fundamental psychic tendency. On the abnormal side we find it in the synesthesias which, since Galton first drew attention to them in 1883 in his "Inquiries into Human Faculty," have become well known and are found among between six to over twelve per cent. of people. Galton investigated chiefly those kinds of synesthesias which he called "number-forms" and "color associations." The number-form is characteristic of those people who almost invariably think of numerals in some more or less constant form of visual imagery, the number instantaneously calling up the picture. In persons who experience color-associations, or colored-hearing, there is a similar instantaneous manifestation of particular colors in connection with particular sounds, the different vowel sounds, for instance, each constantly and persistently evolving a definite tint, as *a* white, *e* vermilion, *i* yellow, etc., no two forms, however, having exactly the same color scheme of sounds. These phenomena are not so very rare and, though they must be regarded as abnormal, they occur in persons who are perfectly healthy and sane.

It will be seen that a synesthesia—which may involve taste, smell

and other senses besides hearing and sight—causes an impression of one sensory order to be automatically and involuntarily linked on to an impression of another totally different order. In other words, we may say that the one impression becomes the *symbol* of the other impression, for a symbol—which is literally a throwing together—means that two things of different orders have become so associated that one of them may be regarded as the sign and representative of the other.

There is, however, another still more natural and fundamental form of symbolism which is entirely normal, and almost, indeed, physiological. This is the tendency by which qualities of one order become symbols of qualities of a totally different order because they instinctively seem to have a similar effect on us. In this way, things in the physical order become symbols of things in the spiritual order. This symbolism penetrates indeed the whole of language; we can not escape from it. The sea is *deep* and so also may thoughts be; ice is *cold* and we say the same of some hearts; sugar is *sweet,* as the lover finds also the presence of the beloved; quinine is *bitter* and so is remorse. Not only our adjectives, but our substantives and our verbs are equally symbolical. To the etymological eye every sentence is full of metaphor, of symbol, of images that, strictly and originally, express sensory impressions of one order, but, as we use them to-day, express impressions of a totally different order. Language is largely the utilization of symbols. This is a well-recognized fact which it is unnecessary to elaborate.[1]

An interesting example of the natural tendency to symbolism, which may be compared to the allied tendency in dreaming, is furnished by another language, the language of music. Music is a representation of the world—the internal or the external world—which, except in so far as it may seek to reproduce the actual sounds of the world, can only be expressive by its symbolism. And the symbolism of music is so pronounced that it is even expressed in the elementary fact of musical pitch. Our minds are so constructed that the bass always seems *deep* to us and the treble *high.* We feel it incongruous to speak of a *high* bass voice or a *deep* soprano. It is difficult to avoid the conclusion that this and the like associations are fundamentally based, that there are, as an acute French philosophic student of music, Dauriac (in an essay "Des Images Suggerées par l'Audition musicale") has expressed it, "sensorial correspondences," as, indeed, Baudelaire had long since divined; that the motor image is that which demands from the listener the minimum of effort; and that music almost constantly evokes motor imagery.[2]

[1] Ferrero, in his "Lois Psychologiques du Symbolisme" (1895), deals broadly with symbolism in human thought and life.

[2] The motor imagery suggested by music is in some persons profuse and apparently capricious, and may be regarded as an anomaly comparable to a synesthesia. Heine was an example of this and he has described in "Florentine

The association between high notes and physical ascent, between low notes and physical descent is certainly in any case very fixed.[3] In Wagner's "Lohengrin," the ascent and descent of the angelic chorus is thus indicated. Even if we go back earlier than the days of Bach the same correspondence is found. In the work of Bach himself—pure and abstract as his music is generally considered—this as well as much other motor imagery may be found, as is now generally recognized by students of Bach, following in the steps of Albert Schweitzer and André Pirro. It is sometimes said that this is "realism" in music. That is a mistake. When the impressions derived from one sense are translated into those of another sense there can be no question of realism. A composer may attempt a realistic representation of thunder, but his representation of lightning can only be symbolical; audible lightning can never be realistic.

Not only is there an instinctive and direct association between sounds and motor imagery, but there is an indirect but equally instinctive association between sounds and visual imagery which, though not itself motor, has motor associations. Thus Bleuler considers it well established that among color-hearers there is a tendency for photisms that are light in color (and belonging, we may say, to the "high" part of the spectrum) to be produced by sounds of high quality, and dark photisms by sounds of low quality; and, in the same way, sharply-defined pains or tactile sensations as well as pointed forms produce light photisms. Similarly, bright lights and pointed forms produce high phonisms, while low phonisms are produced by opposite conditions. Urbantschitisch, again, by examining a large number of people who were not color-hearers found that a high note of a tuning fork seems higher when looking at red, yellow, green or blue, but lower if looking at violet. Thus two sensory qualities that are both symbolic of a third quality are symbolic to each other.

This symbolism, we are justified in believing, is based on fundamental organic tendencies. Piderit, nearly half a century ago, forcibly argued that there is a real relationship of our most spiritual feelings

Nights" the visions aroused by the playing of Paganini, and elsewhere the visions evoked in him by the music of Berlioz. Though I do not myself experience this phenomenon I have found that there is sometimes a tendency for music to arouse ideas of motor imagery; thus some melodies of Handel suggest a giant painting frescoes on a vast wall space. The most elementary motor relationship of music is seen in the tendency of many people to sway portions of their body—to "beat time"—in sympathy with the music. Music is fundamentally an audible dance, and the most primitive music is dance music.

[3] The instinctive nature of this tendency is shown by the fact that it persists even in sleep. Thus Weygandt relates that he once fell asleep in the theater during one of the last scenes of "Cavalleria Rusticana," when the tenor was singing in ever higher and higher tones, and dreamed that in order to reach the notes the performer was climbing up ladders and stairs on the stage.

and ideas to particular bodily movements and facial expressions. In a similar manner, he pointed out that bitter tastes and bitter thoughts tend to produce the same physical expression.[4] He also argued that the character of a man's looks—his *fixed* or *dreamy* eyes, his *lively* or *stiff* movements—correspond to real psychic characters. If this is so we have a physiological, almost anatomical, basis for symbolism. Cleland,[5] again, in an essay "On the Element of Symbolic Correlation in Expression," argued that the key to a great part of expression is the correlation of movements and positions with ideas, so that there are, for instance, a host of associations in the human mind by which "upward" represents the good, the great, and the living, while "downward" represents the evil and the dead. Such associations are so fundamental that they are found even in animals, whose gestures are, as Féré[6] remarked, often metaphorical, so that a cat, for instance, will shake its paw, as if in contact with water, after any disagreeable experiences.

The symbolism that to-day interpenetrates our language, and indeed our life generally, has mostly been inherited by us, with the traditions of civilization, from an antiquity so primitive that we usually fail to interpret it. The rare additions we make to it in our ordinary normal life are for the most part deliberately conscious. But so soon as we fall below, or rise above, that ordinary normal level—to insanity and hallucination, to childhood, to savagery, to folk-lore and legend, to poetry and religion—we are at once plunged into a sea of symbolism.[7] There is even a normal sphere in which symbolism has free scope and that is in the world of dreams.

Oneiromancy, the symbolical interpretation of dreams, more especially as a method of divining the future, is a wide-spread art in early stages of culture. The discerning of dreams is represented in the old testament as a very serious and anxious matter (as in regard to Pharoah's dream of the fat and lean cattle), and, nearer to our time, the dreams of great heroes, especially Charlemagne, are represented as highly important events in the medieval European epics. Little manuals on the interpretation of dreams have always been much valued by the uncultured classes, and among our current popular sayings there are many dicta concerning the significance, or the good or ill luck, of particular kinds of dreams.

Oneiromancy has thus slowly degenerated to folk-lore and superstí-

[4] T. Piderit, "Mimik und Physiognomik," 1867, p. 73.

[5] J. Cleland, "Evolution, Expression and Sensation," 1881.

[6] Féré, "La Physiologie dans les Métaphores," *Revue Philosophique*, October, 1895.

[7] Maeder discusses symbolism in some of these fields in his "Die Symbolik in den Legenden: Märchen, Gebräuchen und Träumen," *Psychiatrisch-Neurologische Wochenschrift*, Nos. 6 and 7, May, 1908.

tion. But at the outset it possessed something of the combined dignities of religion and of science. Not only were the old dream-interpreters careful of the significance and results of individual dreams in order to build up a body of doctrine, but they held that not every dream contained in it a divine message; thus they would not condescend to interpret dreams following on the drinking of wine, for only to the temperate, they declared, do the gods reveal their secrets. The serious and elaborate way in which the interpretation of dreams was dealt with is well seen in the treatise on this subject by Artemidorus of Daldi, a native of Ephesus, and contemporary of Marcus Aurelius. He divided dreams into two classes of *theorematic* dreams, which come literally true, and *allegorical* dreams. The first group may be said to correspond to the modern group of prophetic, proleptic or prodromic dreams, while the second group includes the symbolical dreams which have of recent years again attracted attention. Synesius, who lived in the fourth century and eventually became a Christian bishop without altogether ceasing to be a Greek pagan, wrote a very notable treatise on dreaming in which, with a genuinely Greek alertness of mind, he contrived to rationalize and almost to modernize the ancient doctrine of dream symbolism. He admits that it is in their obscurity that the truth of dreams resides and that we must not expect to find any general rules in regard to dreams; no two people are alike, so that the same dream can not have the same significance for every one, and we have to find out the rules of our own dreams. He had himself (like Galen) often been aided in his writings by his dreams, in this way getting his ideas into order, improving his style, and receiving criticisms of extravagant phrases. Once, too, in the days when he hunted, he invented a trap as a result of a dream. Synesius declares that our attention to divination by dreams is good on moral grounds alone. For he who makes his bed a Delphian tripod will be careful to live a pure and noble life. In that way he will reach an end higher than that he aimed at.[8]

It seems to-day by no means improbable that, amid the absurdities of this popular oneiromancy, there are some items of real significance. Until recent years, however, the absurdities have frightened away the scientific investigator. Almost the only investigator of the psychology of dreaming who ventured to admit a real symbolism in the dream world was Scherner,[9] and his arguments were not usually accepted nor

[8] A translation of Synesius's "Treatise on Dreams" is given by Druon, "Œuvres de Synésius," pp. 347 *et seq.*

[9] K. A. Scherner, "Das Leben des Traumes," 1861. In France Hervey de Saint-Denis, in a remarkable anonymous work which I have not seen ("Les Rêves et les Moyens de les Diriger," p. 356, quoted by Vaschide and Piéron, "Psychologie du Rêve," p. 26), tentatively put forward a symbolic theory of dreams, as a possible rival to the theory that permanent associations are set up as the result of a first chance coincidence. "Do there exist," he asked,

even easy to accept. When we are faced by the question of definite and constant symbols it still remains true that scepticism is often called for. But there can be no manner of doubt that our dreams are full of symbolism.[10]

The conditions of dream-life, indeed, lend themselves with a peculiar facility to the formation of symbolism, that is to say, of images which, while evoked by a definite stimulus, are themselves of a totally different order from that stimulus. The very fact that we *sleep,* that is to say, that the avenues of sense which would normally supply the real image of corresponding order to the stimulus are more or less closed, renders symbolism inevitable.[11] The direct channels being thus largely choked, other allied and parallel associations come into play, and since the control of attention and apperception is diminished, such play is often unimpeded. Symbolism is the natural and inevitable result of these conditions.[12]

It might still be asked why we do not in dreams more often recognize the actual source of the stimuli applied to us. If a dreamer's feet are in contact with something hot, it might seem more natural that he should think of the actual hot-water bottle, rather than of an imaginary Etna, and that, if he hears a singing in his ears, he should argue the presence of the real bird he has often heard rather than a performance of Haydn's "Creation" which he has never heard. Here, however, we have to remember the tendency to magnification in dream imagery, a tendency which rests on the emotionality of dreams. Emotion is nor-

"bizarre analogies of internal sensations in virtue of which certain vibrations of the nerves, certain instinctive movements of our viscera, correspond to sensations apparently quite different? According to this hypothesis experience would bring to light mysterious affinities, the knowledge of which might become a genuine science; . . . and a real key to dreams would not be an unrealizable achievement if we could bring together and compare a sufficient number of observations."

[10] It is interesting to note that hallucinations may also be symbolic. Thus the Psychical Research Society's Committee on Hallucinations recognized a symbolic group and recorded, for instance, the case of a man who, when his child lies dying sees a blue flame in the air and hears a voice say "That's his soul" (*Proceedings Society Psychical Research,* August, 1894, p. 125).

[11] Maeder states that the tendency to symbolism in dreams and similar modes of psychic activity is due to "vague thinking in a condition of diminished attention." This is, however, an inadequate statement and misses the central point.

[12] In the other spheres in which symbolism most tends to appear, the same or allied conditions exist. In hallucinations, which (as Parish and others have shown) tend to occur in hypnagogic or sleep-like states, the conditions are clearly the same. The symbolism of an art, and notably music, is due to the very conditions of the art, which exclude any appeal to other senses. The primitive mind reaches symbolism through a similar condition of things, coming as the result of ignorance and undeveloped powers of apperception. In insanity these powers are morbidly disturbed or destroyed, with the same result.

mally heightened in dreams. Every impression reaches sleeping consciousness through this emotional atmosphere, in an enlarged form, vaguer it may be, but more massive. The sleeping brain is thus not dealing with actual impressions—if we are justified in speaking of the impressions of waking life as "actual"—even when actual impressions are being made upon it, but with transformed impressions. The problem before it is to find an adequate cause, not for the actual impression but for thè transformed and enlarged impression. Under these circumstances symbolism is quite inevitable. Even when the nature of an excitation is rightly perceived its quality can not be rightly perceived. The dreamer may be able to perceive that he is being bitten but the massive and profound impression of a bite which reaches his dreaming consciousness would not be adequately accounted for by the supposition of the real mosquito that is the cause of it; the only adequate explanation of the transformed impression received is to be found (as in a dream of my own) in a creature as large as a lobster. This creature is the symbol of the real mosquito.[13] We have the same phenomenon under somewhat similar conditions in the intoxication of chloroform and nitrous oxide.

The obscuration during sleep of the external sensory channels and the checks on false conclusions they furnish is not alone sufficient to explain the symbolism of dreams. The dissociation of thought during sleep, with the diminished attention and apperception involved, is also a factor. The magnification of special isolated sensory impressions in dreaming consciousness is associated with a general bluntness, even an absolute quiescence, of the external sensory mechanism. One part of the organism, and it seems usually a visceral part, is thus apt to magnify its place in consciousness at the expense of the rest. As Vaschide and Piéron say, during sleep "the internal sensations develop at the expense of the peripheral sensations." That is indeed the secret of the immense emotional turmoil of our dreams. Yet it is very rare for these internal sensations to reach the sleeping brain as what they are. They become conscious not as literal messages, but as symbolical transformations. The excited or laboring heart recalls to the brain no memory of itself but some symbolical image of excitement or labor. There

[13] The magnification we experience in dreams is manifested in their emotional aspects and in the emotional transformation of actual sensory stimuli, from without or from within the organism. The size of objects recalled by dreaming memory usually remains unchanged, and if changed it seems to be more usually diminished. "Lilliputian hallucinations," as they are termed by Leroy, who has studied them (*Revue de Psychiatrie*, 1909, No. 8), in which diminutive, and frequently colored, people are observed, may occasionally occur in alcoholic and chloral intoxication, in circular insanity and in various other morbid mental conditions. They are usually agreeable in character, and constitute a micropsia which is supposed to be due to some disturbance in the cortex of the brain.

is association, indeed, but it is association not along the matter-of-fact lines of our ordinary waking civilized life but along much more fundamental and primitive channels, which in waking life we have now abandoned or never knew.

There is another consideration which may be put forward to account for one group of dream-symbolisms. It has been found that certain hysterical subjects of old standing when in the hypnotic state are able to receive mental pictures of their own viscera, even though they may be quite ignorant of any knowledge of the shape of these viscera. This *autoscopy,* as it has been called, has been specially studied by Féré, Comar and Sollier.[14] Hysteria is a condition which is in many respects closely allied to sleep, and if it is to be accepted as a real fact that autoscopy occasionally occurs in the abnormal psychic state of hypnotic sleep in hysterical persons, it is possible to ask whether it may not sometimes occur normally in the allied state of sleep. In the hypnotic state it is known that parts of the organism normally involuntary may become subject to the will; it is not incredible that similarly parts normally insensitive may become sufficiently sensitive to reveal their own shape or condition. We may thus indeed the more easily understand those premonitory dreams in which the dreamer becomes conscious of morbid conditions which are not perceptible to awaking consciousness until they have attained a greater degree of intensity.

The recognition of the transformation in dream life of internal sensations into symbolic motor imagery is ancient. Hippocrates said that to dream, for instance, of springs and wells denoted some disturbance of the bladder. Sometimes the symbolism aroused by visceral processes remains physiological; thus indigestion frequently leads to dreams of eating, as of chewing all sorts of inedible and repulsive substances, and occasionally—it would seem more abnormally—to agreeable dreams of food.

It is due to the genius of Professor Sigmund Freud, of Vienna—to-day the most daring and original psychologist in the field of morbid psychic phenomena—that we owe the long-neglected recognition of the large place of symbolism in dreaming. Scherner had argued in favor of this aspect of dreams, but he was an undistinguished and unreliable psychologist and his arguments failed to be influential. Freud avows himself a partisan of Scherner's theory of dreaming and opponent of all other theories,[15] but his treatment of the matter is incomparably

[14] Sollier, "L'Autoscopie Interne," *Revue Philosophique,* January, 1903. Sollier deals with the objections made to the reality of the phenomenon.

[15] Freud, "Die Traumdentung," p. 66. This work, published in 1900, is the chief and most extensive statement of Freud's views. A shorter statement is embodied in a little volume of the "Grenzfrägen" Series, "Ueber den Traum," 1901. A brief exposition of Freud's position is given by Dr. A. Maeder of Zurich in "Essai d'Interpretation de Quelques Rêves," *Archives de Psychologie,*

more searching and profound. Freud, however, goes far beyond the fundamental—and, as I believe, undeniable—proposition that dream-imagery is largely symbolic. He holds that behind the symbolism of dreams there lies ultimately a *wish;* he believes, moreover, that this wish tends to be really of more or less sexual character, and, further, that it is tinged by elements that go back to the dreamer's infantile days. As Freud views the mechanism of dreams, it is far from exhibiting mere disordered mental activity, but is (much as he has also argued hysteria to be) the outcome of a desire, which is driven back by a kind of inhibition or censure (*i. e.,* that kind of moral check which is still more alert in the waking state) and is seeking new forms of expression. There is first in the dream the process of what Freud calls condensation (Verdichtung), a process which is that fusion of strange elements which must be recognized at the outset of every discussion of dreaming, but Freud maintains that in this fusion all the elements have a point in common, and overlie one another like the pictures in a Galtonian composite photograph. Then there comes the process of displacement or transference(Verschrebung), a process by which the really central and emotional basis of the dream is concealed beneath trifles. Then there is the process of dramatization or transformation into a concrete situation of which the elements have a symbolic value. Thus, as Maeder puts it,[16] summarizing Freud's views, "behind the apparently insignificant events of the day utilized in the dream there is always an important idea or event hidden. We only dream of things that are worth while. What at first sight seems to be a trifle is a gray wall which hides a great palace. The significance of the dream is not so much held in the dream itself as in that substratum of it which has not passed the threshold and which analysis alone can bring to light."

"We only dream of things that are worth while." That is the point at which many of us are no longer able to follow Freud. That dreams of the type studied by Freud do actually occur may be accepted; it may even be considered proved. But to assert that all dreams must be made to fit into this one formula is to make far too large a demand. As regards the presentative element in dreams—the element that is

April, 1907; as also by Ernest Jones, "Freud's Theory of Dreams," *Review of Neurology and Psychiatry,* March, 1910, and *American Journal of Psychology,* April, 1910. For Freud's general psychological doctrine, see Brill's translation of "Freud's Selected Papers on Hysteria," 1909. There have been many serious criticisms of Freud's methods. As an example of such criticism, accompanying an exposition of the methods reference may be made to Max Isserlin's "Die Psychoanalytische Methode Freuds," *Zeitschrift für die Gesamte Neurologie und Psychiatrie,* Bd. I., Heft 1, 1910. A judicious and qualified criticism of Freud's psychotherapeutic methods is given by Löwenfeld, "Zum gegenwärtigen Stande der Psychotherapeutie," *Münchener medizinische Wochenschrift,* Nos. 3 and 4, 1910.

[16] *Loc. cit.,* p. 374.

based on actual sensory stimulation—it is in most cases unreasonable to invoke Freud's formula at all. If when I am asleep the actual song of a bird causes me to dream that I am at a concert, that picture may be regarded as a natural symbol of the actual sensation and it is unreasonable to expect that psycho-analysis could reveal any hidden personal reason why the symbol should take the form of a concert. And, if so, then Freud's formula fails to hold good for phenomena which cover one of the two main divisions of dreams, even on a superficial classification, and perhaps enter into all dreams.

But even if we take dreams of the remaining or representative class —the dreams made up of images not directly dependent on actual sensation—we still have to maintain a cautious attitude. A very large proportion of the dreams in this class seem to be, so far as the personal life is concerned, in no sense "worth while." It would, indeed, be surprising if they were. It seems to be fairly clear that in sleep, as certainly in the hypnagogic state, attention is diminished, and apperceptive power weakened. That alone seems to involve a relaxation of the tension by which we will and desire our personal ends. At the same time by no longer concentrating our psychic activities at the focus of desire it enables indifferent images to enter more easily the field of sleeping consciousness. It might even be argued that the activity of desire when it manifests itself in sleep and follows the course indicated by Freud, corresponds to a special form of sleep in which attention and apperception, though in modified forms, are more active than in ordinary sleep.[17] Such dreams seem to occur with special frequency, or in more definitely marked forms, in the neurotic and especially the hysterical, and if it is true that the hysterical are to some extent asleep even when they are awake, it may also be said that they are to some extent awake even when they are asleep. Freud certainly holds, probably with truth, that there is no fundamental distinction between normal people and psychoneurotic people, and that there is, for instance, as Ferenczi says emphasizing this point, "a streak of hysterical disposition in everybody." Freud has, indeed, made interesting analytic studies of his own dreams, but the great body of material accumulated by him and his school is derived from the dreams of the neurotic. Thus Stekel states that he has analyzed many thousand

[17] This is supported by the fact that in waking revery, or day-dreams, wishes are obviously the motor force in building up visionary structures. Freud attaches great importance to revery, for he considers that it furnishes the key to the comprehension of dreams (*e. g.*, "Sammlung Kleiner Schriften zur Neurosenlehre," 2d series, pp. 138 *et seq.*, 197 *et seq.*). But it must be remembered that day-dreaming is not real dreaming which takes place under altogether different physiological conditions, although it may quite fairly be claimed that day-dreaming represents a state intermediate between ordinary waking consciousness and consciousness during sleep.

dreams, but his lengthy study on the interpretation of dreams deals exclusively with the dreams of the neurotic.[18] Stekel believes, moreover, that from the structure of the dream life conclusions may be drawn not only as to the life and character of the dreamer, but also as to his neurosis, the hysterical person dreaming differently from the obsessed person, and so on. If that is the case we are certainly justified in doubting whether conclusions drawn from the study of the dreams of neurotic people can be safely held to represent the normal dream-life, even though it may be true that there is no definite frontier between them.[19] Whatever may be the case among the neurotic, in ordinary normal sleep the images that drift across the field of consciousness, though they have a logic of their own, seem in a large proportion of cases to be quite explicable without resort to the theory that they stand in vital but concealed relationship to our most intimate self.

Even in waking life, and at normal moments which are not those of revery, it seems possible to trace the appearance in the field of consciousness of images which are evoked neither by any mental or physical circumstance of the moment, or any hidden desire, images that are as disconnected from the immediate claims of desire and even of association as those of dreams seem so largely to be. It sometimes occurs to me—as doubtless it occurs to other people—that at some moment when my thoughts are normally occupied with the work immediately before me, then suddenly appears on the surface of consciousness a totally unrelated picture. A scene arises, vague but usually recognizable, of some city or landscape—Australian, Russian, Spanish, it matters not what—seen casually long years ago, and possibly never thought of since, and possessing no kind of known association either with the matter in hand or with my personal life generally. It comes to the surface of consciousness as softly, as unexpectedly, as disconnectedly, as a minute bubble might arise and break on the surface of an actual stream from ancient organic material silently disintegrating in the depths beneath.[20]

[18] The special characteristics of dreaming in the hysterical were studied, before Freud turned his attention to the question, by Sante de Sanctis, "I Sogni e il Sonno nell' Isterismo," 1896.

[19] See also Havelock Ellis, "Studies in the Psychology of Sex," Vol. I., 3d ed., 1910, "Auto-crotism."

[20] Gissing, the novelist, an acute observer of psychic states, in the most personal of his books, "The Private Papers of Henry Ryecroft," has described this phenomenon: "Every one, I suppose, is subject to a trick of mind which often puzzles me. I am reading or thinking, and at a moment, without any association or suggestion that I can discover, there rises before me the vision of a place I know. Impossible to explain why that particular spot should show itself to my mind's eye; the cerebral impulse is so subtle that no search may trace its origin." Gissing proceeds to say that a thought, a phrase, an odor, a touch, a posture of the body, may possibly have furnished the link of association, but he knows no evidence for this theory.

Every one who has traveled much can not fail to possess, hidden in his psychic depths a practically infinite number of such forgotten pictures, devoid of all personal emotion. It is possible to maintain, as a matter of theory, that when they come up to consciousness, they are evoked by some real though untraceable resemblance which they possess with the psychic or physical state existing when they reappear. But that theory can not be demonstrated. Nor, it may be added, is it more plausible than the simple but equally unprovable theory that such scenes do really come to the surface of consciousness, as the result of some slight spontaneous disintegration in a minute cerebral center and have no more immediately preceding psychic cause than my psychic realization of the emergence of the sun from behind a cloud has any psychic preceding cause.

Similarly, in insanity, Liepmann in his study "Ueber Ideenflucht" has forcibly argued that ordinary logorrhea—the incontinence of ideas linked together by superficial associations of resemblance or contiguity—is a linking *without direction,* that is, corresponding to no interest, either practical or theoretical, of the individual. Or, as Claparède puts it, logorrhea is a trouble in the reaction of *interest* in life. It seems most reasonable to believe that in ordinary sleep the flow of imagery follows, for the most part, the same easy course. That course may to waking consciousness often seem peculiar, but to waking consciousness the conditions of dreaming life are peculiar. Under these conditions, however, we may well believe that the tendency to movement in the direction of least resistance still prevails. And as attention and will are weakened and loosened during sleep, the tense concentration on personal ends must also be relaxed. We become more disinterested. Personal desire tends for the most part rather to fall into the background than to become more prominent. If it were not a period in which desire were ordinarily relaxed sleep would cease to be a period of rest and recuperation.

Sleeping consciousness is a vast world, a world only less vast than that of waking consciousness. It is futile to imagine that a single formula can cover all its manifold varieties and all its degrees of depth. Those who imagine that all dreaming is a symbolism which a single cypher will serve to interpret must not be surprised if, however unjustly, they are thought to resemble those persons who claim to find on every page of Shakespeare a cypher revealing the authorship of Bacon. In the case of Freud's theory of dream interpretation, I hold the cypher to be real, but I believe that it is impossible to regard so narrow and exclusive an interpretation as adequate to explain the whole world of dreams. It would, *a priori,* be incomprehensible that sleeping consciousness should exert so extraordinary a selective power among the variegated elements of waking life, and, experientially, there seems

no adequate ground to suppose that it does exert such selective action. On the contrary, it is, for the most part, supremely impartial in bringing forward and combining all the manifestations, the most trivial as well as the most intimate, of our waking life. There is a symptom of mental disorder called *extrospection* in which the patient fastens his attention so minutely on events that he comes to interpret the most trifling signs and incidents as full of hidden significance, and may so build up a systematized delusion.[21] The investigator of dreams must always bear in mind the risk of falling into morbid extrospection.

Such considerations seem to indicate that it is not true that every dream, every mental image, is "worth while," though at the same time they by no means diminish the validity of special and purposive methods of investigating dream consciousness. Freud and those who are following him have shown, by the expenditure of much patience and skill, that his method of dream-interpretation may in many cases yield coherent results which it is not easy to account for by chance. It is quite possible, however, to recognize Freud's service in vindicating the large places of symbolism in dream, and to welcome the application of his psycho-analytic method to dreams, while yet denying that this is the only method of interpreting dreams. Freud argues that all dreaming is purposive and significant and that we must put aside the belief that dreams are the mere trivial outcome of the dissociated activity of brain centers. It remains true, however, that, while reason plays a larger part in dreams than most people realize—the activity of dissociated brain centers furnishes one of the best keys to the explanation of psychic phenomena during sleep. It would be difficult to believe in any case that in the relaxation of sleep our thoughts are still pursuing a deliberately purposeful direction under the control of our waking impulses. Many facts indicate—though Freud's school may certainly claim that such facts have not been thoroughly interpreted—that, as a matter of fact, this control is often conspicuously lacking. There is, for instance, the well-known fact that our most recent and acute emotional experiences—precisely those which might most ardently formulate themselves in a wish—are rarely mirrored in our dreams, though recent occurrences of more trivial nature, as well as older events of more serious import, easily find place there. That is easily accounted for by the supposition —not quite in a line with a generalized wish-theory—that the exhausted emotions of the day find rest at night.

It must also be said that even when we admit that a strong emotion may symbolically construct an elaborate dream edifice which needs analysis to be interpreted, we narrow the process unduly if we assert that the emotion is necessarily a wish. Desire is certainly very funda-

[21] Extrospection has been specially studied by Vaschide and Vurpas in "La Logique Morbide."

mental in life and very primitive. But there is another equally fundamental and primitive emotion—fear.[22] We may very well expect to find this emotion, as well as desire, subjacent to dream phenomena.[23]

The wish-dream of the kind elaborately investigated by Freud may be accepted as, in what he terms its infantile form, extremely common, and, even in its symbolic forms, a real and not rare phenomenon. But it is impossible to follow Freud when he declares that the wish-dream is the one and only type of dream. The world of psychic life during sleep is, like the waking world, rich and varied; it can not be covered by a single formula. Freud's subtle and searching analytic genius has greatly contributed to enlarge our knowledge of this world of sleep. We may recognize the value of his contribution to the psychology of dreams while refusing to accept a premature and narrow generalization.

[22] On the psychic importance of fears, see G. Stanley Hall, "A Study of Fears," *American Journal of Psychology*, 1897, p. 183. Metchnikoff ("Essais Optimistes," pp. 247 *et seq.*) insists on the mingled fear and strength of the anthropoid apes.

[23] Foucault has pointed this out, and Morton Prince, and Giessler (who admits that the wish-dream is common in children), and Flournoy (who remarks that not only a fear but any emotion can be equally effective), as well as Claparède. The last admits that Freud might regard a fear as a suppressed desire, but it may equally be said that a desire involves, on its reverse side, a fear. Freud has indeed himself pointed out (*e. g.*, *Jahrbuch für Psychoanalytische Forschungen*, Bd. 1, 1909, p. 362) that fears may be instinctively combined with wishes; he regards the association with a wish of an opposing fear as one of the components of some morbid psychic states. But he holds that the wish is the positive and fundamental element: "The unconscious can only wish" ("Das Unbewusste kann nichts als wünschen"), a statement that seems somewhat too metaphysical for the psychologist.

MODERN MEDIEVALISM

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HISTORY moves in a spiral, not in a circle. History does not accommodatingly repeat itself; but it does pass through cycles in which new eras contain social elements and forces which approximate those of periods belonging to earlier cycles. The new is merely the old garbed in more modern attire. The United States is to-day entering upon an epoch in its history which will be marked, in the economic field, by many resemblances to the medieval period. The fundamental economic problems of medievalism clustered around just and fair prices and wages. At present the important and difficult economic problems relate to "reasonable rates," "fair prices" and "living wages." In the twentieth century when these old medieval questions clothed in a strange and youthful garb, appear in an industrial and nominally democratic country and age, the crux of the difficulty is found in the absence of a standard by means of which to measure fair prices, reasonable rates and living wages. The old and rigid status of the feudal régime has disappeared in a large measure under the pressure of the doctrines of free competition and of non-interference. Mobility, rather than fixity, is characteristic of to-day.

The nineteenth century was a unique and transitional era; it constituted the dark ages of economic history. During that eventful period, it was assumed that prices, rates and wages were fixed by the ceaseless action of free and untrameled competition. But, to-day, the existence of numerous rate and arbitration commissions is a concrete and unmistakable warning that free competition does not act at the present moment as our theorists of the past have dogmatically argued that it did. Day by day the competitive field is being gradually narrowed. A strip is securely fenced in on this side; and another portion encroached upon at an entirely different point. At the present moment great and important fields of industrial activity are clearly seen to be outside the competitive sphere. It must, however, be recognized that competition in the halcyon days of the *laissez faire* doctrine was not really free. It was modified and regulated by such legal conventions as private property, inheritance, laws in regard to contract, custom and a variety of other obstructions. The game of economic competition among human beings has always been played according to certain rules. But these rules change. Custom is broken down, on one hand, while monopoly encroaches upon the competitive field, on the other side.

The thinking public correctly recognizes that railway and street railway fares, gas, electric light, water, telephone and telegraph rates are not fixed by a competitive process. Insistent demand is made for fair and reasonable rates in this class of semi-public service. The labor

unionist struggles for fair and living wages. Even the individualistic American farmers are earnestly striving to fix "fair" prices for their wheat, oats, corn, tobacco and other crops. Australia attempts to make the application of a protective tariff to a given establishment dependent upon the payment of "fair" wages to the employees of that concern. A Wisconsin commission is industriously placing a valuation upon the physical property of the public utilities corporations of that state, in order that "reasonable" rates may be promulgated by that official body.

In this manner, the ground is being rapidly cut from under the competitive basis of price regulation. Our commercial edifice still rests on this substructure; but the foundation walls are crumbling, and ominous cracks which presage decay and demolition are appearing in the structure. Society is impregnated with the idea that competition is no longer efficient and sufficient as a guide. From all sections of the country come reports of rate commissions, boards of arbitration, gentlemen's agreements, combinations and legal actions against restraint of trade.

With the narrowing of the competitive sphere the question as to what is a just, accurate and scientific standard of measurement for wages, prices and rates becomes increasingly important; and, at the same time, it becomes more difficult to solve because the basis of competitive rates, prices and wages is being undermined. In fact, if no standard can be found, socialism or anarchy seem to be the only alternatives. Much of the discussion and theorizing as to the respective rights of labor and capital is worthless because either free competition is assumed, or reference is made to prices or wages paid in the past; or some arbitrary standard is postulated which has no reality outside the personal desires of certain individuals or classes.

No court of arbitration or board of conciliation has as yet offered any definite and scientific formula by means of which disputes as to wages or conditions of labor may be adjusted. The findings of that famous board of arbitration, the Anthracite Coal Strike Commission, merely offered a compromise; the commission did not dig down to the roots of the difficulty. Neither did an anxious public receive any exact data or the formulation of any definite method of procedure which might be used as a basis for the work of future boards. A peace was patched up, and the mines were opened. The members of the strike commission honestly and faithfully tried to take into account the physical, social and economic conditions then existing in the anthracite district. They investigated the home and working environment of the miner; his condition was compared with that of other workers. Yet after all, the principal value of this investigation consisted in emphasizing the rights of the general public. The decisions of the Interstate Commerce Commission and of the various state railway and public utilities commissions as to reasonable rates are invariably determined by reference to profits received upon investments in competitive busi-

nesses. An Ohio judge in dissolving a combination of ice dealers ordered the reestablishment of the price charged during the preceding year.

The decision of this judge bears a close resemblance to the action of the English government as to wages immediately after the black death. The present movement toward the regulation of prices, rates and wages is distinctly a reversion to conditions preceding the nineteenth century; and the importance and extent of the movement will necessitate a thorough search for a reliable and scientific standard for the determination of fair wages and fair prices. The medievalists had a very definite conception of fair price; men of to-day are not so favored. During the middle ages these problems were solved by means of the inelastic measuring rod of status, or of class demarkation. Each class in the community had its own rather definite and customary standard of living; and the summit of personal ambition was success within a limited social and economic sphere rather than that of progress from one class to the next higher. Ambition was curbed and chastened by the great fact of birth within a given social compartment. The attempt was made so to regulate prices as to maintain class immobility. With the advent of the era of competition the rigidity of class demarkation was destroyed; and a democratic form of government resting on broad suffrage requirements makes a return improbable. The modern student or statesman instead of resting his theory of fair price upon a basis of special privilege, must place it upon the firm foundation of equality of privileges, upon the abolition of artificial and inherited inequalities. This return to medievalism does not mean a return to artificial and unyielding class demarkations. Society is moving toward a point farther up on the spiral of history. The return to medievalism does mean the elimination of forced and monopoly gains; and is a natural and inevitable product of the progress toward democracy.

If the cornerstone upon which medieval writers based their doctrines regarding fair price has been removed by the increasing power of the non-privileged class; what is left upon which to build a new and democratic doctrine of fair price? In the modern formulation of the doctrine, a fair price for an article or a service is one which will give to the workers who have any useful part in getting the article into the hands of the final consumer, whether that part be in obtaining the raw material, transforming or exchanging these materials, a "fair wage." A fair price will also give to capital a "reasonable rate" of interest, and to the entrepreneur or manager—the man whose genius guides and directs the business—such a return as will keep him in the business and will call forth his best efforts. A fair price does not contain elements which go to make up monopoly profits, or to reward the efforts of unnecessary workers in the complex system of modern industry. This is the basic principle upon which the new economic edifice must be anchored. Competition has led to combination, and combination to

monopoly. A theory of price is needed which preserves the economic value of combination; and, at the same time, removes the evil features of special privileges and of monopoly.

A fair wage is as yet a very elusive and indefinite concept. A fair wage for an unskilled worker would not be a fair wage for the skilled man. The needs of the man are, in the last analysis, the chief factors in determining fair wages. Subjective, rather than objective, considerations have the greatest weight in the eye of modern man. Here is a point of contrast between the modern and the medieval view point. Again, social considerations enter into the problem. How will the man make use of his income? Society desires that a large income go to the man who will make the best use of it—the use which will tend to advance the progress of humanity. A multitude of different opinions will be expressed as to the best uses of income; but certain fundamental conditions are almost universally accepted. Excessive luxury and wasteful consumption in living, in eating, in drinking and the like, are condemned at the bar of society. In general, it is for the good of society that expenditures for luxuries be sent for durable goods rather than upon highly perishable commodities. A fair price for all articles and services would tend to place wealth and income in the hands of those best fitted to handle it; those who would make the best use of it judged from the somewhat theoretical view-point of society as a whole, but not from the standpoint of any special class in the community. A fair wage in an ideal industrial organism would give to each according to his needs; and needs would be proportional to efficiency.

Distribution must now be considered from a non-competitive point of view; and the storm center of discussion will be found in the treatment of rents or monopoly gains. Wages are individual products; but interest and rents must be held to be social, or at least semi-social, products. Social evolution has, it is true, made possible the existing rates of wages; but a sharp line of demarkation may be drawn between wages on the one side, and rent and interest on the other. Individual traits and characteristics play an important part in fixing wages. On the contrary, rents accrue because of social progress, not because of individual efficiency. The man who invests capital is frequently able to gain a personally unearned income, to draw dividends, for example, upon watered stocks. But the man who furnishes his labor receives no extra or special gain. He runs no risk; but in a multitude of cases, the returns accruing to the capitalist or the promoter bear no discernible relation to the risk involved. Individuals are able magically to make capital—paper capital, but of a kind that bears interest. Labor is unable by any sleight-of-hand performance to double or treble its equipment. A dollar may through stock watering, aided by gifts of franchises and rights of way or by special privileges, be apparently changed into two dollars and draw the income of two; but the laborer in the same business can not make it appear that he has four hands or

a dual personality as a worker, and thus double his pay check. In the matter of market opportunity the opportunity is with capital, not with labor. Extra income due to special advantages is capitalized in money, not in labor power.

"Fair" interest and "fair" profits may be manipulated through capitalization of special privileges; but "fair" wages can not be so acted upon. The man stands out in the open. Fair wages are kept down because fair interest and fair profits are so elusive; and because rents are concealed under the guise of interest upon concrete capital, or of profits due to skilful management. If the capital of the country were expressed only in terms of concrete tangible goods, as is proposed by the Wisconsin law, the disproportion between fair wages and fair profits and interest would be evident. The enormous gains of monopoly would then inevitably attract such attention that they would be cut off to some extent at least, and the long distance, impersonal and indirect form of tribute taking would be reduced; although a scientific basis for determining fair wages, interest and profits may not be found.

But there are other tangible bits of evidence which bring to the nostrils of the investigator the musty smell of medievalism. A corporation furnishing a municipality with water which is supposed to be taken from artesian wells, finds it feasible and perhaps cheaper to introduce, into the water mains, without notice to the consumers of the city, polluted water from a river. As a consequence, sickness and death invade many happy homes in the little city. Another company producing a food product uses a deleterious preservative to enable it to foist a partially spoiled article upon an ignorant and unsuspecting public. Sickness, ill-health, reduced efficiency and even death follow unnoticed in the wake of the packages sent broadcast over the land. A railway company neglects to guard its street crossings or to protect its trainmen because of the additional expense connected with such improvements. Again, dead and maimed men, women and children are the direct results of the policy of the heads of the company. This disregard for employees and consumers which is by no means confined to a few isolated cases, is not unlike the nonchalance with which the knight and baron of the middle ages directed the destruction of the homes and the crops of his adversaries and competitors. The toll of the monopolist collected in prices made arbitrarily high is not very different from the toll exacted at the point of the sword by the robber baron.

In the medieval period, a multitude of evils resulted from the interference of the church in secular affairs. To-day political chicanery and corruption are the fruits of the interference of big business interests in legislative affairs. The trust has replaced the church as a dangerous meddler in political affairs. And the alliance between capital and the state is as dangerous, as reactionary and as intolerant as was the medieval alliance of church and state. Economic heresy is now almost as bitterly condemned as was religious heresy in earlier centuries.

THE NATURE OF DISEASE AND OF ITS CURE

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THE earliest explanation of disease, corresponding to the ideas of nature which first impressed the dawning human consciousness, was that the usual working of the body had been upset by the entrance into it of an evil spirit. This spirit proceeded to disturb the "ease" of the body of the sick man, causing it to reject and eject food, racking it with pain, and burning it with the slow fire of fever, and even talking through its lips in incoherent or mysterious utterances. So satisfactory an explanation did this seem that, in modified form, it has a hold with the more superstitious even in the present day.

Such being the cause for his sufferings, the primitive man was prompt to see that the cure should be the driving out of the evil spirit which had taken up its abode in the body, by the most appropriate methods. The medicine man of the tribe assumed a superior knowledge in such affairs and took upon himself the responsibility of dealing with these unseen powers. Working upon the reasonable assumption that what appealed to human senses must also appeal to the dwellers in the spirit realm, that what was agreeable or disagreeable to one must be agreeable or disagreeable to the other, this healer proceeded to make it very unpleasant for the tormentor of the sick man by appearing before him in his most hideous garb, by the repetition of frightful cries and thunderous thumpings upon his tom-tom, while draughts made of the most vile and disgusting substances were poured down the throat of the victim in the hope that the spirit would be induced to let go his hold and depart. It was the most logical treatment imaginable, and it seemed so proved by the fact that the sick man very often recovered. Nor did the primitive mind stop at the mere driving out of the source of disease, but followed up its success in this direction by equally rational attempts at prevention by the wearing of some magic object to keep away the demon of sickness in the future.

As men became more observant and thoughtful, it became apparent that certain physical conditions seemed to have much to do with the presence of sickness. While the spirit realm might be finally responsible for the singling out of the sufferer, yet extremes of heat and cold, dampness, lack of food, and some other agencies were seen to be get-at-able causes. Moreover, it was discovered, more or less accidentally, that the application of heat and cold, bathing, rubbing, and the use of

certain plants often gave comfort and apparently often helped the sick man to recover. So arose the more materialistic cure of disease and the profession of physicians.

By those who studied disease from the more material standpoint many theories were devised to explain the phenomena displayed by the sick. The lack of knowledge of the minute or even the gross structure of the body and its working in health, necessarily made all these attempts at explanation more or less crude and imperfect. Every conceivable "cure" was tried from age to age, and, no matter what the means employed, whether gold or clay, sassafras or tar water, whether the patient was bled or whether sharp hooks were applied to his flesh in order to "draw out the humors," always a certain percentage of patients recovered from the disease and survived the treatment. For the time, at least, the "cure" was apparently justified by the results, and held its place in practise until a change of theories or an unusually long list of failures threw it into disrepute, and it was relegated to the list of things which "have been used but are now found of little value."

The more obvious causes of disease—intemperance, exposure to heat and cold, exhaustion, etc.—were early connected with certain forms of bodily ailments, and even diseases like malaria were known to depend somewhat on local conditions of living, but it is only within recent years that such common affections as pneumonia, tuberculosis, influenza, etc., have been found to have a tangible cause working within the body.

With the discovery of bacteria and their poisons there still remained the questions, What is disease? Why, even in times of plague, are some persons exempt? and why do certain persons recover and others succumb even with the same treatment?

We can no longer look upon sickness as due to the presence within or without us of an evil-natured personality. We must reverse the idea and say that disease is the manifestation of a good consciousness within us, a consciousness which seeks to maintain life by endeavoring to rid the body of a harmful material presence. We realize through abnormal sensations that we are sick—that the body has undergone a change from the condition of health, but within us is a more elemental intelligence of which we are not aware, an older body-mind which, whether we sleep or wake, and even before we are born into consciousness of self, looks after the highly complex and interdependent structures on which life depends, constantly directing its complicated affairs with unerring faithfulness. Disease may be said to be the effort made by the body, directed by this deeper mind, in its attempt to rid itself in most appropriate ways of whatsoever it finds harmful to it, or that threatens its destruction. A fit of vomiting, in which the conscious mind takes a passive and even unwilling part, is but the wise attempt on the part of this inner consciousness to rid the body of that which it finds to be harmful. In the

case of the presence of bacteria, they are at once detected by this bodily consciousness, though the higher consciousness is unaware of their presence. The agencies within the blood, capable of destroying the germs and of neutralizing their poisons, are set to work at high pressure. To the higher consciousness and to the observing mind of another person these efforts become apparent in higher bodily temperature (fever), a more rapid pulse and increased respiration. The bodily machinery is stirred to higher activity, its fires are heightened, and its organs are quickened. Germ-destroying substances are being made in greatest possible amount. The "signs and symptoms" of the disease, or these outward manifestations of internal activity, differ with the kind of germs and with their numbers, the body working more or less characteristically in each case, so that for each germ the "symptoms and signs" are an index to the cause.

Such a disease or body-fight must "run its course," and, no matter what the treatment, that course can at best only be shortened, or the struggle of the body with its enemy made less exhausting by help from without. Where the number of bacteria is large or especially vicious, or where the bodily powers are inadequate for promptly developing its resisting powers, the fight of the body may be of no avail, even with the most skillful aid. On the other hand, if the bacteria are few and the bodily powers are vigorous, the patient will recover even with the most absurd treatment. It is easy to see why the medicine man of primitive society and the miracle workers of a later age often succeeded in "driving out" disease and in effecting apparently marvelous cures.

After once having an infectious disease, such as typhoid, or measles, the body is often exempt from an attack by the same germ. We now know it is not because of special divine favor bestowed upon the individual, but because the body, after passing through one struggle with the bacteria, keeps on hand afterwards a defensive material which quickly destroys any germs of the same kind which find an entrance.

Even in times of epidemics and among those associated with the sick, a certain number of persons always escape without serious signs of the prevailing disease. While the germs no doubt often attack such persons, their protective powers are so perfect that the machinery of the body does not have to be put at work in such a degree as to produce any conscious outward signs of the disease.

For some of these bacterial invasions modern medicine has invented the wonderful expedient of producing, in other animals, similar substances to those which the human body manufactures in its fight against the germs. By inoculating these into the human body the microbes can be prevented from gaining a lodgment, or the body can be greatly aided in its fight against them. Although the body can be thus aided in diphtheria and meningitis, for the attacks of most germs it

must still depend on its own resources in a successful fight against the marauders.

Most of the infectious diseases are of short duration, the body triumphing or failing in its fight in from one to five or six weeks; yet some such fights are long drawn out, and, as in tuberculosis, may cover many years, the disease—the fight—varying in success with the resources of the body and with the amount of drain of bodily energy in other directions. Whether brief or long drawn out, whether acute or chronic, the bodily antagonists often leave scars in the shape of damaged organs—lasting ills which serve to render the body less perfect in its working than before, and also leave their impress on the higher consciousness in feelings of weakness and discomfort.

Besides the bacteria and their poisonous products, other things produce disease more or less insidiously. While the body naturally rids itself through certain organs of the waste matter—the ashes and smoke of its daily activities, continued excesses in eating or drinking throw extra work upon those organs, which in time wear out under added burdens. Exhausting work, excesses of heat or cold, and other unusual conditions also bring about reaction of the inner bodily consciousness to adjust the body to its surroundings. The body makes the best of a bad matter and does its utmost to bring itself into harmony with its outer conditions.

Disease is, then, a life-saving effort of the body, directed by its inner consciousness, in ridding itself of harmful substances within, or of compensating for injured or overworked organs. It is the next best thing to health in that it is nature's way of attempting to bring the body back to that harmonious working of all parts which we call health, and often also of producing protecting substances which prevent future injury from the same source.

While the treatment rendered by the earliest healer, the medicine man, must seem to us absurd, so far as any direct alleviation of suffering is concerned, we can not but guess that the hope which his presence and his, to us, useless efforts inspired in the sufferer, helped not a little to stimulate, through the mind, the failing bodily forces. Mind and body are so intimately related that what affects the one affects the other, and throughout the history of the treatment of disease mental influence has always been used directly or indirectly, consciously or unconsciously, to aid in restoring the body to its state of health.

The higher conscious mind is intimately a part of, or a manifestation of, the body, and is affected by bodily conditions of well or ill being. While it can take little part in directing the defense against foes which have gained an entrance to the body, the mental conditions—the emotions of hope or discouragement—indirectly support or depress the whole of the bodily fighting machinery, for the organ through which

the mind works is closely connected with every other organ of the body and so influences digestion, circulation and all other functions. Likewise the mind is affected by the bodily states. The ill working of damaged organs may produce a mental state of pain or depression. These feelings may be heightened or diminished by mental effort, or may be more or less forgotten, for the time at least, by directing consciousness into some other channel of activity. Disease is, in every case, modified more or less by the mind, and the mental state may sometimes help to determine the success or failure of bodily fight against destructive agencies. If appeal to the mind seems to cure the bodily ill, it does not indicate that the patient would not have recovered anyhow, and does not signify that the mind itself effected the return to health. No amount of faith or other mental state can take the place of insufficient body-resources—can restore a damaged lung or a missing limb.

Disease being thus the attempt of the body to restore itself to its usual condition by ridding itself of destructive agents, the treatment of disease must be directed toward helping the body to this end, by putting the mental and muscular forces at rest, by proper nourishment and by such antitoxins or drugs as aid it in its natural efforts to rid itself of harmful conditions. Better still are the efforts toward prevention of infectious and other injuries by the avoidance of intemperance in eating and drinking, by breathing fresh air, by cleanliness, and by such other means as the body demands to keep it at its best working power. Lastly, the mind should be trained not to meddle too much with bodily affairs, save as it observes the laws of hygiene, and it should be educated to deal readily with the trials and vexations of life in a way that will not affect the general health through depressing emotional discharges.

It will be seen that our modern faith healers make no difference between diseases as regards their cause. In their ignorance, comparable only to that of the primitive medicine man, they deal with all sickness alike. While the condition of the mind has much to do with some diseases, with others it has little or no part in the cure, and the body itself must work out its salvation through that wise inner body-directing intelligence which the higher mind can not know nor—but to a slight extent—influence. The faith curist in the conceit of his ignorance takes the credit for the cures which, through good fortune plus a grain of mental stimulus, often come to pass under his administrations, while he who has studied into the physical nature of disease is perfectly aware that when his patient recovers he has only assisted nature more or less in what she would probably have accomplished without his help though usually not so easily and completely and sometimes not at all. It is this humble knowledge of the limitations of his art that makes the

physician the more anxious, in this age, to prevent disease, for he realizes it is much easier to remove the cause than to help the body in its efforts to throw off the attack. By the purification of drinking water he has greatly reduced the amount of disease from typhoid; by furnishing pure milk the sickness and death of infancy have become much less; by recommending life in pure air tuberculosis is less frequent, etc. Mere faith or mind cure has done and can do nothing of the sort. Medical teaching has also warned against intemperance of all kinds, and against other insidious destroyers of bodily harmony.

The physician has in all ages made use of mental treatment, for, no matter what his remedy in physical form, there has always gone with it a grain of hope. Where he finds the mind especially at fault he may even appeal to it directly, and thus relieve suffering which had its origin chiefly in mental depression or in a too exuberant and untutored imagination. He often succeeds in producing more harmony in bodily working by establishing a happier mental and moral view of life.

As the prevention of the entrance of bacteria or of any other injurious agent into the body is far more economical than the helping to overcome the damages these may produce, so the prevention of unhappy and unhealthy mental states is far better than an attempt to restore a mind to right habits from which it has lapsed.

In primitive times one minister looked after both the spiritual and bodily health of the individual. As the doctor of medicine later assumed the cure of the body, so the doctor of divinity took as his special province the cure of the soul. Mind and body react upon each other, and he who ministers to the one can not but influence the other to some extent. While the priest has abundant opportunity for helping to heal soul-injuries, his larger work, like that of the physician, lies in surrounding those he would help with better social conditions, and in developing, through religious and philosophic training, their individual powers of resistance to the stresses to which the moral nature is daily subjected. For both physical and spiritual ailments prevention is far easier and better than cure.

THE PALEONTOLOGIC RECORD

PALEONTOLOGIC EVIDENCES OF CLIMATE

By T. W. STANTON

U. S. GEOLOGICAL SURVEY

TO every one climate is an interesting theme. The climates of the past, especially when they can be shown to differ in character or distribution from those of the present, attract the attention of the general public, and they are of importance to the special student of geologic history whether his researches deal with the purely physical aspects of the subject or include some branch of paleontologic study.

The evidence as to former climates comes from many sources. The records of deposition and denudation in themselves sometimes give more or less definite indications concerning variations in temperature or moisture or both; the land floras when compared with those now living by their general characters and by the details of their structure, show more or less clearly the climatic conditions under which they lived; the land animals, especially the higher vertebrates, afford a good basis for inferring their habits and hence indirectly their environment, including climate; marine invertebrates give trustworthy evidence of differences in temperature of oceanic littoral waters at least in the later periods. It is obvious, however that the data furnished by any one of these lines of evidence will make only unconnected fragments of the history of past climates and that the evidence on the climate of any particular epoch, if derived from a single source, is seldom so complete or so convincing that corroborative testimony from other sources is not desirable. The subject is one in which general cooperation is essential.

It should be stated at the outset that the most abundant and most definite evidence comes from paleobotany, and will be outlined in Mr. White's paper. The discussion of the data derived from fossil vertebrates must also be left for some one who is qualified to present it, and the whole Paleozoic era may be passed over with the statement that so far as indications from the animal life are concerned the climate of the whole earth was mild and equable. The proof of local exceptions to this statement comes from other sources.

All inferences from paleontologic evidence as to former climatic conditions rest in the final analysis on a comparison with the present distribution of animals and plants with reference to climate. Such comparisons may be general or specific, direct or indirect, and the con-

clusions that may be drawn from them vary greatly in positiveness. To take a familiar example, the reef-building corals are now restricted to shallow waters in which the mean temperature during the coldest month in the year is not less than 68° F., and such conditions are not found in the northern hemisphere north of latitude 32°. Since late Tertiary corals differ but little from those of the present time it is justifiable to assume that coral reefs in late Tertiary rocks indicate waters of about the temperature stated. But when Jurassic coral reefs are found as far north as latitude 53° it is by no means so certain that they indicate a minimum monthly mean temperature of 68° F., and concerning Devonian and Silurian coral reefs in high latitudes the doubt must be still greater. At the present time large reptiles are mainly confined to hot moist climates, but that fact alone can not be considered proof that the Mesozoic dinosaurs required the same kind of a climate.

The impress of climate on the present fauna is shown in various ways. A tropical fauna contains the greatest number of species and exhibits its luxuriance in other ways. Thus, taking shell-bearing marine mollusks to illustrate the general law, Dall has shown in Bulletin 84, U. S. Geological Survey, that the average tropical fauna in shallow waters consists of over 600 species, while the temperate fauna has less than 500 species, and the boreal fauna only 250. Again, there are certain genera that are characteristic of particular zones, and assemblages of forms that are recognized as belonging only to frigid, or temperate, or tropical waters, and in genera that have a wide range many of the species are restricted to certain limits of temperature.

In the late Tertiary faunas which contain a large proportion of living genera and many living species justifiable inferences as to climate may be made from direct comparison with living faunas. By one or another of the tests just indicated, or by a combination of them, Dall has produced convincing evidence that the Oligocene fauna of the Atlantic states was subtropical and that the Oligocene maintains its subtropical character even as far north as Arctic Siberia. He has also shown that the Miocene fauna of Maryland indicates a temperate climate and that a similar cool-water fauna extended at that time as far south as Florida.[1] The fossils of the raised Pliocene beaches at Nome, Alaska, according to the same investigator, furnish evidence of warmer climate during Pliocene time even at that high latitude. By similar methods, in a paper published in the *Journal of Geology,* Vol. XVII., Arnold has recently argued for a series of climatic changes in the late Tertiary and Pleistocene of California.

When the investigation is carried back to the Mesozoic and earlier

[1] See especially Dall's "Contributions to the Tertiary Fauna of Florida," published as Vol. III. of the *Transactions of the Wagner Free Institute of Science,* Philadelphia, and a chapter in the Miocene volume of the Maryland Geological Survey.

faunas in which few of the genera and none of the species are identical with those now living the problem becomes more difficult and the conclusions are much less definite, as the comparisons must be more general. Proofs of actual temperatures as measured in degrees should not be expected unless the botanists can furnish data. There is, however, great local differentiation of faunas and it is fair to ask the question to what extent this is due to differences in climate. One of the earliest discussions of this question was by Ferdinand Roemer, who more than fifty years ago in "Die Kreidebildungen von Texas" noted the fact that the Cretaceous of the highlands in Texas is lithologically and faunally much like the Cretaceous of southern Europe and the Mediterranean region, that it differs from the Cretaceous of New Jersey in about the same way that the southern European Cretaceous differs from that of England and northwestern Germany, and that in each case the European deposit is approximately 10° farther north than its American analogue. He concluded that the differences between the northern and southern facies were due to climate and that the climatic relations between the two sides of the Atlantic were about the same in Cretaceous time as they are now. Roemer's conclusion that there were climatic zones in the Cretaceous may be true, but his reasoning was based on false premises so far as the American deposits are concerned, for the New Jersey type of marine Cretaceous extends with little change all the way from New Jersey to the Rio Grande, and the "Cretaceous of the highlands" with which he contrasted it, now known as the Comanche series, is not represented by marine beds on the Atlantic coast. This shows the necessity for careful stratigraphic and areal work as well as for good paleontology before such broad conclusions can be safely made.

The more general work of Neumayr[2] recognized in the Jurassic and Cretaceous of Europe three faunal provinces designated as boreal, central European, and alpine or equatorial, which on account of their zonal distribution he regarded as indicating climatic differences. He believed that these zones are recognizable throughout the northern hemisphere and cited evidence to show that similar zones exist south of the equator. In recent years Neumayr's conclusions have been questioned by many because in so many instances genera supposed to be characteristic of one zone have been found mingled with those of another. For example, the alpine ammonite genera *Lytoceras* and *Phylloceras* occur in Alaska (lat. 60°) associated with the boreal *Aucella,* and *Aucella* itself ranges from the Arctic Ocean to the torrid zone. Still, in spite of such exceptions and anomalies in distribution, there is much evidence for a real distinction between boreal and southern faunas in the Jurassic and in the Cretaceous which may indicate a zonal distribution of temperature in Mesozoic time. It should be

[2] "Erdgeschichte," Vol. II., p. 330 et seq.

remembered, however, that a boreal climate probably did not then mean a frigid climate, and that the differences in temperature were probably not so great as at the present time.

The conclusions justified by the evidence from fossil invertebrates are:

1. In the Paleozoic there is practically no faunal evidence of climatic zones comparable with those that now exist.

2. In the Mesozoic there is a more or less definite zonal distribution of faunas which may be in part due to differences in climate but this conclusion in each case should be checked by the study of the floras and all other available lines of evidence.

3. From the middle of the Tertiary on through the Pleistocene trustworthy conclusions as to climatic conditions and changes can be made by direct comparisons with the distribution of living faunas.

THE MIGRATION AND SHIFTING OF DEVONIAN FAUNAS

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IN the year 1881 I presented before the American Association for the Advancement of Science the first definite announcement of the theory of recurrent faunas, applying it to the fauna of the Marcellus, Genesee and Ithaca black shales of New York, which I then conceived to be represented by the continuous fauna of the black shales of Ohio, Indiana, Kentucky and Tennessee; and also in the same paper the theory of shifting of faunas was applied to the Hamilton and Chemung faunas of central New York.[1] Since that time a large amount of evidence has been accumulated confirming these hypotheses.

The two hypotheses are correlated. Recurrence, or the departure of a fauna, its replacement by another and its final reappearance in the same section at a higher level, become the facts upon which the hypothesis of shifting of the faunas is based; and only on the assumption of the continuance and shifting of a fauna without losing its characteristics can we satisfactorily explain its recurrence.

The following facts are among the more important which have come to light in the course of my studies:

§ 1. *The Catskill sedimentation* was shown to be thicker and to start lower down in the geological column in eastern New York than in middle and western New York. In eastern New York it began while the Hamilton marine fauna was still present and cut it off, bringing in estuarian conditions with a brackish water and land fauna and flora. In middle New York no Catskill sedimentation is present until after

[1] *Proc. American Association for the Advancement of Science,* Vol. XXX., p. 186, etc.

the arrival of the Chemung fauna; and in western New York no trace of the Catskill type of sediments appears till after the close of the Devonian.

These facts are direct evidence of shifting of the environmental conditions of the edge of the continent westward as the deposits of the middle and upper Devonian were being laid down. With this shifting westward of the off-shore conditions of the sea, there went on a corresponding shifting of several faunas that were adjusted to each phase of those conditions.

These facts were stated in a paper on the classification of the upper Devonian published in 1885.[2]

§ 2. *The Appearance of Dominant Species of a General Fauna in Reversed Order of Succession at the Close of a Fossiliferous Zone.*— The case of *Spirifer lævis* in the Ithaca Zone and of the frequent appearance of *Leiorhynchus* at the opening and close of a fossiliferous zone were among the earliest observed facts suggesting the actual shifting of the body of the fauna entering the area in one order of succession and its departure in the reverse order. In the Ithaca section there occurs at the base of the fossiliferous zone of the Ithaca member a bed containing abundance of *Spirifer* (*Reticularia*) *lævis.* The discovery of the same species at the top of the fossiliferous zone as the normal Ithaca fauna become sparse gave the first suggestion that the faunas were moving or shifting. The Reticularia zone marked the first trace of the fauna to enter and the last to leave the area. Confirmatory evidence was also found in the order of succession of the dominant species of the Ithaca fauna. These facts were reported in 1883.[3]

§ 3. The study of the *mode of occurrence of Leiorhynchus* still further drew attention to the definite order in which series of species came in and went out of any given area. The species of the genus were generally found abundantly at the base or at the top of the fossiliferous zones rich in the brachiopods in the midst of which *Leiorhynchus* was rare.[4]

§ 4. The *reappearance* in a single or few strata of several *representatives of an earlier fauna* long after the formation to which they were normal had ceased.

Slight traces of this fact were observed in the first survey of the Devonian section passing through Ithaca, reported in 1883, Bull. 3, U. S. G. S., and the fauna No. 14 N (p. 15) was called a recurrent Hamilton fauna because of the appearance there of such species as *Spirifer fimbriatus, S. augustus, Pleurotomaria capillaria* and others;

[2] *Proc. American Association for the Advancement of Science,* XXXIV., p. 222.

[3] Bull. 3, U. S. G. S., p. 20, and 1885 *Proc. A. A. A. S.,* Vol. XXXIV., p. 222, etc.

[4] See Bull. 3, U. S. G. S., pp. 16 and 17, 1883.

and higher up in the midst of the Chemung section at Chemung narrows *Tropidoleptus carinatus* and *Cypricardella bellistriata, Phacops bufo* and *Dalmanites calliteles* were found.

The discovery of such traces of an earlier fauna led to further search; and as the evidence accumulated an elaboration and definite formulation of the theory of recurrence of faunas was made which has been set forth in several papers, and is illustrated in detail in the folio of the Watkins Glen-Catatonk quadrangles, which is now in press, for the U. S. Geological Survey (December, 1909).

The facts there brought out are substantially as follows: There are exhibited in the sections mapped for the quadrangles two series of fossiliferous zones; the separate zones of the two series alternate in succession; the zones of one series dominate the western sections of the area and thus thin out or disappear on tracing them eastward; the zones of the second series dominate the eastern sections and particularly the whole eastern New York sections, but thin out westward and in some cases are entirely wanting in sections west of the Watkins Glen quadrangle. The first set of faunal zones includes the faunas of the Genesee shale, the Portage formation and the several divisions of the Chemung formation.

The second set of zones includes the Hamilton fauna proper and recurrent representatives of that fauna which I have named the *Paracyclas lirata* zone, the *Spirifer mesistrialis* zone, the *Leiorhynchus globuliformis* or Kattel Hill zone. These zones are represented by the typical Ithaca group of Hall in its typical sections at Ithaca; and above them appear the first, second and third recurrent Tropidoleptus faunas (which I originally named the Van Etten, the Owego and the Swartwood Tropidoleptus zones, respectively). All of these several fossiliferous zones of the second set become decidedly thin on passing westward across the region. The Ithaca fauna is, occasionally, detected west of the Watkins Glen quadrangle, but is confined to less than 100 feet thickness at Watkins, is recognized for three hundred feet at Ithaca and ranges through at least 600 feet along Tioughnioga River.

Only a slight trace of the Paracyclas zone is seen as far west as Ithaca, but it is well expressed in the section on the east side of the area. The Van Etten, Owego and Swartwood Tropidoleptus zones appear in thin tongues of strata as far west as the Waverly quadrangle and are seen in occasional traces as far west as the Elmira quadrangle. When followed eastward they appear to blend together as a modified Hamilton fauna sparsely appearing in the strata up to the income of the Catskill type of sedimentation.

Where the Hamilton recurrent zones are seen in sharpest expression the recurrent species range through only a foot or a few feet of strata, hold in abundance four or five characteristic Hamilton species such as

Tropidoleptus carinatus, Cypricardella bellistriata, Rhipidomella vanuxemi, Spirifer marcyi and *Delthyris mesacostalis* (= *D. consobrinus*) and others; and the Owego and Swartwood zones appear in the midst of a characteristic Chemung fauna both above and below them. In the Owego recurrent zone both *Phacops rana* and *Dalmanites calliteles* occur.

The Van Etten recurrent zone lies entirely below the range of *Spirifer disjunctus* and associated species of the Chemung formation. On following the sections eastward from the Waverly quadrangle the species of the Chemung fauna become scarce, and east of the Chenango River very few species of the typical Chemung fauna have been detected —although they are still abundant in the Chemung rocks to the southeast and southward across Pennsylvania, Maryland and Virginia.

§ 5. These facts have been interpreted as evidence not only of a general *shifting of faunas* coincident with a rising of the land along the eastern edge of the present continent, but of *oscillation of conditions* and *alternate occupation of the area* by two sets of faunas coming from opposite directions and temporarily living in abundance in the area of central New York.

§ 6. The *lithologic changes* in the sediments containing the different faunas are not sufficient to account for the change in fauna. In quite a number of sections there is no appreciable difference in lithologic constitution between the strata which for a hundred feet thickness have been filled with characteristic Chemung species and the immediately following thin zone (of a foot or two) with scarcely a trace of the Chemung species, but holding, in great number, species which if found by themselves would be undisputed evidence of the Hamilton formation.

§ 7. It becomes necessary therefore to suppose that the *controlling cause* determining the presence of one or other fauna is not the character of the bottom on which the sediments which preserved the fauna were laid. We are thus led to conclude that the qualities of the ocean water have determined the shifting or migration of the faunas. The conditions to which the faunas were adjusted were evidently those of depth, salinity or temperature of the waters in which the species lived; and their change of habitation was occasioned by change in the direction, path or extent of flow of oceanic currents.

This leads us to consider the principles of migration as affecting marine organisms.

§ 8. *Migration of Species and Shifting of Faunas.*—Migration as commonly applied in natural history means the movement of large numbers of the same species from one place to another in a general definite direction at more or less regular periodic times. So birds migrate northward with the advance of warm weather; some fish migrate

from sea up rivers in breeding seasons; pigeons fly eastward or westward in great flocks, or grasshoppers invade a rich country devouring the vegetation in their path, or lemmings migrate across country in great quantities.

The term in these cases has to do with movements of one kind of animal in relation to the comparatively stable range of feeding-ground for the remainder of the fauna inhabiting the areas concerned. The term is rarely if ever applied to the slower movement of the whole body of animals of a fauna, coincident with great changes of climate, such as the advance of the glacial cover over the northern parts of Europe or America produced during the glacial age, or the advance of an Asiatic fauna across the Bering Straits and down the west coast of North America at some Pleistocene time when an ice bridge furnished means of communication by land from one continent to the other. Perhaps there is no impropriety in extending the application of the term migration to these latter cases in which the whole fauna and flora of a region is affected instead of single or a few species; and in which the change of position of habitat is slow and spread over a great period of time instead of being coincident with annual change of seasons. The term may equally well be applied to movements in the seas and movements on the lands.

There is, however, one reason for choosing a separate name for the movements of the latter kind to distinguish them from typical migrations.

In the first class of cases the migration is voluntary and is performed by those organisms which have the power of more or less rapid locomotion. They may be said to do the migrating themselves. In the second case the movements are involuntary and the movement is forced upon all the living organisms of the region and the change in position may be supposed to take place by the contracting on one side of the area of the conditions of possible existence for the species and the extension on the other side of favorable conditions of environment. The movements extend over many generations of life so that relatively sedentary species may gradually adjust their *locus habitans* to a given direction of migration. To this latter process of migration I have been accustomed to apply the term "shifting of faunas."

Migration of species is an expression of the ability of some organisms to appreciate slight changes of favorable conditions of environment and to take advantage of the better conditions during the lifetime of an individual. Shifting of faunas is an expression of the necessity for the perpetuation of the race of certain conditions of environment and the dying out of the whole fauna in the areas from which the favorable conditions are removed with corresponding spread of the fauna into new areas into which the favorable conditions have been shifted.

Shifting of faunas is an expression of the inability of the species of the fauna to survive under the changed conditions of environment which have overwhelmed them in the original habitat; but of an ability on the part of all those which migrate to follow the favorable conditions as they shift from one area to another.

In both typical migration of species and shifting of faunas change in the environmental conditions of life constitute the stimulus to change of habitat on the part of the organisms; and the movement of the organisms is a direct response to the stimulus—those organisms in the first case which migrate showing their greater vitality compared with their neighbors who stay at home; while those who stay at home show a greater power of endurance and organic adjustment to wider range of environmental conditions.

In the case of the shifting faunas those which endure without change of characters exhibit an acquired closeness of adjustment to some particular combination of environmental conditions which they are forced to follow or die and suffer annihilation. The evidence of their endurance is indicated by return and reoccupation of the same area at a later geological stage when by their reappearance, the original condition of environment may be assumed to have recurred.

In the case of living organisms evidence of migration is found in the actual presence of the species at one time in a region at a considerable distance from its ordinary *locus habitans;* and in some cases by seeing the species in the process of migration, as for instance the temporary alighting in fatigued condition of flocks of northern land birds on Bermuda Island on their migration southward.

In the case of fossil species the shifting of a fauna is expressed by the presence of a number of species representing an earlier fauna in a stratum in the midst of rocks containing a different and dominantly later set of species.

The fauna is then said to recur and it is the recurrence of the fauna which forms the basis for the inference that the fauna has shifted its *locus habitans* during the period of time represented by the sedimentary deposits separating the formation in which the fauna is dominant from the zone in the higher formation in which the recurrent species are found.

This theory of the shifting of place and the recurrence in time of the same fauna involves certain conceptions as to the nature of species and the laws of evolution which it is important to consider.

§ 9. *Evidence of Continuity.*—To establish evidence of motion in migration as in any other kind of motion it is all important to know that the body or bodies to which the motion is ascribed is continuously the same.

In the Devonian case I have been studying the moving body is a

fauna; not only have I found it necessary to establish identity of the species in the recurrent zones with those of the initial zones, but it is essential to show that the faunas as a whole are the same.

To put this in another form of statement we must establish the fact that not only the individual species have retained their specific characters, but the further fact that the equilibrium of adjustment to each other in the faunal community has not been changed, in order to prove that the recurrent fauna is the direct successor of a fauna represented in the rocks at a lower horizon.

This has led to such distinction as rare and dominant species of the fauna, and only as some such comparative frequency of the species in the faunal combination is apparent can we be sure that we are not considering an accidentally accumulated sample of a general fauna.

The presence of occasional associated species belonging to the normal fauna of the formation in which the recurrent zone appears is not antagonistic to the theory, because the theory proposes an invading of the territory occupied by the normal fauna, and whatever were the causes which brought about the shifting of the fauna they were not so completely different as to annihilate all evidence of the fauna previously occupying the ground. Hence it is only necessary to find an abrupt change of the grand majority of species to make the induction that the faunas have shifted their habitat.

The theory involves the further conception of grand general faunas which have their center of habitat and distribution in permanent oceanic basins, as distinguished from the special and (in geological strata) temporarily expressed faunas such as we are accustomed to associate with individual geologic formations.

In the case before us two such general faunas are in evidence, one of which in its dominant characteristics is traced westward into Iowa, Idaho and Arizona and up the Mackenzie River valley to the north and across the polar regions to Russia and northern Europe. The other is traced eastward and southward into central and southern Europe and also dominantly into South America.

Although, with our present knowledge, it is not possible to determine in any temporary expression of marine faunas those particular species which were derived from one from those derived from the other grand source, it is possible to recognize numerous species which belong to one center of distribution and others that belong normally to the other.

§10. *Interpretation of the Facts.*—It is also important to keep our heads clear in interpreting the facts.

It is only by close examination and comparison of the fossils themselves that identity of species or identity of faunas can be established.

The fixed characters of species are not only the characters by which

one species is distinguished from another, but they are of generic, ordinal and even class value, and they may be of immense age in the race and mark no special, narrow stage of its history.

It is a question of interpretation whether each particular phase of expression of fluctuating characters is a matter of time or of environment.

I have reached the conclusion that it is those species which have the greater degree of normal and persistent fluctuation of character which migrate and follow the shifting conditions of environment, and their life period is correspondingly longer.

On the other hand species whose plasticity of characters is narrow, are more closely adjusted to their environment, are local in their range of habitat, and temporary in their geological life-period.

Interpreting the facts on this basis it is the phases of continuously fluctuating characters in species of wide geographic distribution and long geologic range which furnish the most satisfactory evidence of temporary stages in the life history of faunas.

Another question of interpretation arises when we attempt to reconstruct the physical condition of the environment at successive stages of time.

In a single vertical section we have positive evidence of succession in time. If we were sure that no recurrence of the same fauna could take place we could correlate two vertical sections strictly upon the fauna contained in the strata, on the basis of the supposition that the single fauna appeared but once in the section and that when it ceased in a given section its whole life period was expressed. But the facts show us that this is not the case in nature. In geological times as in the present, we know that many distinct faunas are living on the face of the earth at the same time, even for very similar conditions of environment. It becomes therefore a very complex matter to correlate two sections in which the order of faunas and the character of the sediments differ; which is generally the case for any two sections separated by fifty miles from each other, although on stratigraphic evidence they may be properly interpreted as covering the same interval of time.

PALEONTOLOGIC EVIDENCES OF ADAPTIVE RADIATION

By Professor HENRY FAIRFIELD OSBORN
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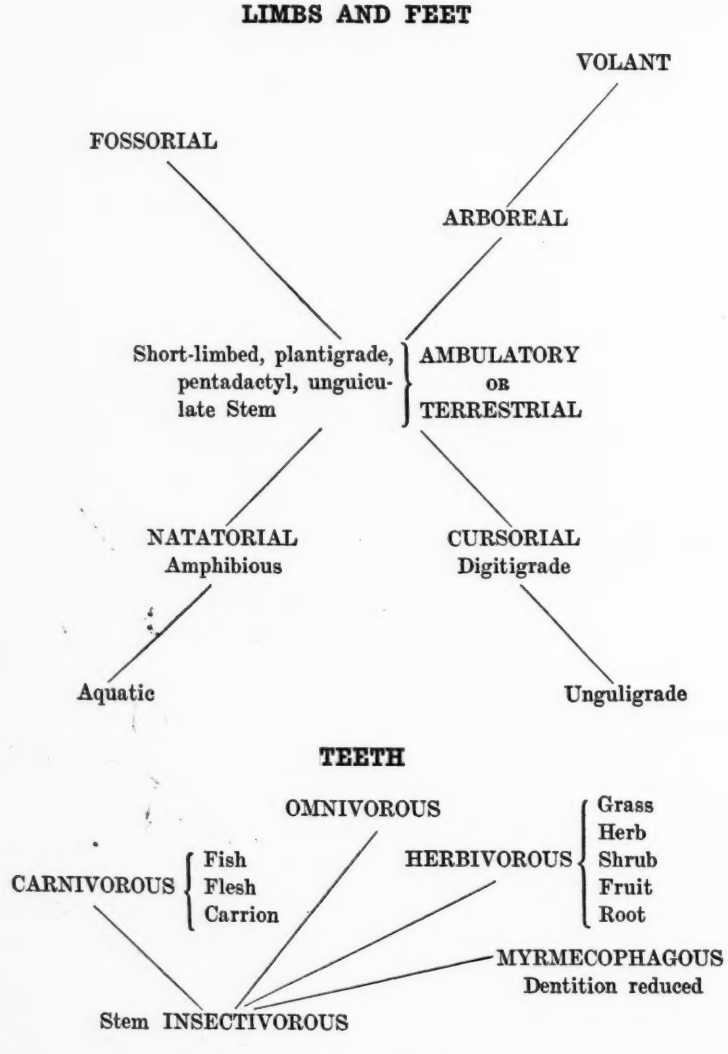
THE law of adaptive radiation[1] is an application of paleontology of the idea of divergent evolution as conceived and developed successively in the studies of Lamarck, Darwin, Huxley and Cope. It

[1] Osborn, H. F., "The Law of Adaptive Radiation," *Amer. Naturalist*, Vol. XXXVI., No. 425, pp. 353–363.

is more than divergence because it implies evolution in every direction from a central form. The idea of radii, or radiations from a central form greatly assists the imagination, because a distinctive feature of paleontology is that we are constantly dealing with fragments of history. The radiations which have been discovered must be supplemented by those which remain to be discovered, and it is very remarkable how in group after group of animals these missing "radii" have turned up.

Radiation actually begins in certain single organs, and the first principle to be observed, as shown in the accompanying diagram, is



MAIN LINES OF ADAPTIVE RADIATION OF (*a*) limbs and feet, (*b*) teeth among mammals.

that radiation of different parts of the body is not necessarily correlated; that is, that the adaptive divergence of the feet and limbs may take one direction, while that of the teeth and skull may take another direction. Thus great variety in combinations of characters may arise, bringing about the very antithesis of Cuvier's supposed "law of correlation"; for we find that while the end results of adaptation are such that all parts of an animal conspire to make the whole adaptive, there is no fixed correlation either in the form or rate of development of parts, and that it is, therefore, impossible for the paleontologist to predict the anatomy of an unknown animal from one of its parts only, unless the animal happen to belong to a type generally familiar. For example, among the land vertebrates the feet, which are associated with the structure of the limbs and trunk, may take one of many lines of adaptation to different media or habitats, either aquatic, terrestrial, arboreal or aerial; while the teeth, which are associated with the structure of the skull and jaws, also may take one of many lines of adaptation to different kinds of food or modes of feeding, whether herbivorous, insectivorous or carnivorous. Through this independent adaptation of different parts of animals to their specific ends there have arisen among vertebrates almost unlimited numbers of combinations of food and tooth structure.

Alternations of Habitat.—In the long vicissitudes of time and procession of continental changes animals have been subjected to alternations of habitat either through their own migrations or through the "migration of the environment itself," to employ Van den Broeck's epigrammatic description of the profound and sometimes sudden environmental changes which may take place in a single locality. The traces of alternations of anatomical adaptation corresponding with these alternations of habitat are recorded both in paleontology and anatomy. For example, Huxley in 1880 briefly suggested the arboreal origin of all the marsupials, a suggestion which has been confirmed abundantly by the detailed studies of Dollo and Bensley, according to which we may imagine that the marsupials have passed through a series of phases, as follows: (1) a very early "terrestrial or ambulatory" phase, (2) a "primary arboreal" phase as exemplified by the tree phalangers of the present day, (3) a "secondary terrestrial" phase as exemplified by the kangaroos and wallabies, (4) a "secondary arboreal" phase as exemplified by the tree kangaroos.

Each one of these phases has left its anatomical record in the structure of the feet and limbs, although this record is often obscured by adaptation.

Louis Dollo especially has contributed most brilliant discussions of this theory of "alternations of habitat" as applied not only to the interpretation of the anatomy of the marsupials but of many kinds of

fishes, and to such reptiles as the herbivorous dinosaurs of the Upper Cretaceous.

This brief consideration of the external features of adaptation leads us to glance at groups of animals. We here observe the influence of geographic distribution; we observe the *adaptive radiation of groups both continental and local.*

Continental Adaptive Radiation.—Among the Tertiary mammals we can actually trace the giving off of radii in several, sometimes in all, directions for the purpose of taking advantage of every opportunity to secure food, to escape enemies, and to reproduce kind, the three phenomena of the struggle for existence. Among such well-known quadrupeds as the horses, rhinoceroses and titanotheres the modifications involved in these radiations can be clearly traced. Thus the history of the life of continents presents a picture of contemporaneous radiations in different parts of the world. We observe the contemporaneous and largely independent radiations of the hoofed animals in South America, in Africa and in the great continent comprising Europe, Asia and North America.

Through the laws of parallelism and convergence each of these radiations produced a greater or less number of analogous groups.

While originally independent, the animals thus evolved separately as autochthonous types in many cases finally mingled together as migrant or invading types.

We may thus work out gradually the separate contributions of the great land masses of North America, South America, etc., to the mammalian fauna of the world. As a rule the greater the continents the more important and fundamental the orders or larger groups of mammals which have radiated in them; the lesser land masses and continental islands, like Australia, have been less favorable to wide adaptive radiation. One of the most interesting features of adaptive radiation is that it may also occur locally.

Local Adaptive Radiation.—On a smaller scale are the local adaptive radiations which occur through segregation of habit and local isolation in the same general geographic region wherever physiographic and climatic differences are sufficiently great to produce local differences in food supply or other local factors of change. This principle is well known among living animals, and it is now being demonstrated among many of the Tertiary mammals, remains of four or five distinct genetic series having been discovered in the same geologic deposits.

The existence of multiple phyla of related animals, as of the rhinoceroses, horses and titanotheres in the same localities is due partly to the operation of the law of local adaptive radiation.

This is conspicuously the case among the titanotheres, for example, the chief evolution of which can be traced in the Rocky Mountain

region. In the Eocene we discover four or five independent local phyla; again in the Oligocene we discover five or six independent local phyla. The evolution of these animals appears to have been chiefly American.

In other cases, however, the polyphyletic condition appears to have been through the mingling with local phyla of phyla evolved in other countries. This is illustrated in the case of the Middle Miocene rhinoceroses of America, which are invaded by rhinoceroses of Eurasiatic or European origin.

In studying the herbivorous quadrupeds, therefore, we must keep in the imagination constantly the production of local phyla through local radiation and the intermingling of foreign phyla through migration. There are a few very striking and profound differences between quadrupeds which recur so frequently that where we discover one form we may surely anticipate the discovery of the opposite or antithetic form: in other words, there are extremes of structure shown in the proportions of the skull, of the teeth, of the limbs, and groups of quadrupeds are constantly tending through adaptive radiation to reach these extremes. Some of the contrasting extremes are the following: brachyodonty *vs.* hypsodonty, dolichocephaly *vs.* brachycephaly, dolichopody *vs.* brachypody.

For example, a local adaptive radiation observed in the horses is that the forest-living types are brachyodont, or possess short-crowned teeth, while the desert-living horses are hypsodont, typically grazers, with long-crowned teeth.

Extremes of long-headedness and short-headedness, of long-footedness and of short-footedness, comprise a very large part of the mechanism of adaptive radiation; but we have to do also with long-necked and short-necked types, and with many other chances of proportion which are correlated with different feeding habits.

INSTINCT AND INTELLIGENCE IN BIRDS—II

By Professor FRANCIS H. HERRICK
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THE cyclical instincts of birds, present, as we have seen, a well-ordered series, rising and waning in due course, until the reproductive cycle is complete. Nevertheless, the order and harmony which commonly prevail are subject to many disturbances of a transient, or of a more lasting character. When variations in the cycle, whatever their nature, become regular and permanent, any consequent loss or injuiry to the species seems to be counterbalanced by the rise of new instincts in both young and adult, which may involve marked structural changes, as shown in the parasitic cuckoos of the old world and their non-parasitic relatives of the new. If transient merely, there is more or less individual loss, according to the nature and extent of the disturbance.

We shall now consider some of these variations in the cyclical series, and we may assume, though with little exact knowledge, that when any character of the sort to be described has become general or permanent this has been effected through a gradual process of selection, with or without environmental influence and other unknown agencies. We may further assume that all modern birds originally built proper nests, and there can be little doubt that many either falter or fail in this work at present through the loss of an instinct which they once possessed; but this question aside, we can be reasonably assured that all originally concealed or guarded their eggs.

The nest, in the first instance, tends to secure a more equable distribution of warmth and moisture for eggs or young; incidentally it may conceal and therefore protect both young and adult, and add to the comfort of the whole family. There would seem to be a vast difference between digging a hole in the warm, moist sand, as we see the turtle, or the moleo, one of the brush turkeys, doing, and weaving through the unremitted efforts of many days, a beautiful pouch like the oriole's, so admirably adapted for protection, both by its form and by its position. Yet it is by no means certain that the fundamental nest-building instinct is entirely wanting in the moleo, the peculiar habits of which will be later considered.

Nest-building of one kind or another is found in all classes of vertebrates, and the guarding and fighting instincts at nesting-time are as strong in some of the fishes as in birds, but while the practise is

clearly of ancient origin, it is by no means universal; it seems in every case to be related to the needs of the animal, and to be a refinement of more simple means of securing both concealment and protection.

The causes of the disturbances, which we have to describe, are wholly obscure. We can only surmise that they may have their origin in changes in the central nervous system, which, as one result, bring about disturbances in nutrition, leading now to a premature, now to a belated development of the reproductive cells. At all events there arises what may be crudely described as an "overlap" or "blending" of instincts. Or, we may say that in the struggle of conflicting impulses victory now goes to one side, now to the other. The only facts that are really known are that the egg sometimes anticipates the nest, instead of the nest the egg, or that the migratory impulse may emerge too soon, and nip the proper parental instincts in the bud, before they have run their course. We do not doubt that the sifting process of selection would soon curb any tendency, like the last, in every species which was destined to survive.

The eccentricities of behavior, which we attribute to disturbances in the breeding cycle, will be examined under the following heads: (1) Beginning a new cycle, and scamping an old; (2) multiple and superimposed nests; (3) eccentric behavior due to conflicting instincts; and (4) premature laying of eggs, omission of nest-building and parasitism.

II. Beginning a New Cycle or Scamping the Old

When the cyclical instincts rise and wane in their proper order, they may be represented by a series of circles tangent to each other, or with but little overlap (Fig. 15). Beginning at term 3 or 4, a cycle[1] is

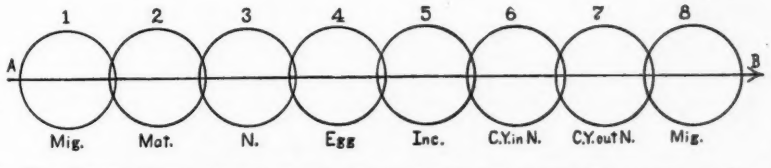


FIG. 15. DIAGRAM TO ILLUSTRATE THE SERIAL INSTINCTS OF THE REPRODUCTIVE CYCLE, with types of activities expressed in eight terms.

completed up to term 7 for each brood successively reared. Most wild birds in this part of the world have but a single brood in the season. The success of any individual pair depends upon circumstances. Storms and predaceous animals of all kinds break down the nests or destroy the eggs, when a fresh start is usually taken.

In very timid birds like the cedar waxwing, the cycle is often

[1] That is, when it is limited to the direct reproductive activities, the relation of which to migration is not important in this discussion.

abruptly ended at term 3 or 4, as a result of fear, through discovery or disturbance of the nest, and a new series is promptly begun at 3. This is the simplest type of disturbance which we can record (Fig. 16).

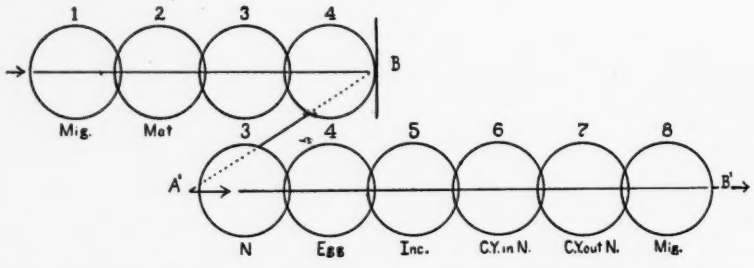


FIG. 16. DIAGRAM OF ANY GIVEN REPRODUCTIVE CYCLE—*A–B*, interrupted by fear or accident at term 4, and a new cycle, A^1B^1, begun at term 3.

The old nest may be torn down by the little builders, and its materials used again, but this does not commonly happen. Since fear is rapidly depressed, with the rise of the brooding instinct, beginning at term 5, interruptions are less liable to occur after this point is reached, but wherever the thread is dropped, it is usually picked up again at stage 3.

Of far greater interest is the fact that a new cycle may be begun at the very close of the breeding season, when it seldom goes far, and is bound to fail for lack of time. Probably no stronger witness to the instinctive basis of the behavior of birds could be found than this recrudescence of the reproductive activities at a time when most must answer the fatal summons of the migratory impulse. It is typically illustrated by the great herring gulls, which toward the close of their usual cycle in mid-July begin to build new nests, and will even lay eggs in them, though all are eventually abandoned. It would not be surprising to find that many young were also left to their fate, but my observations have never extended late enough to determine this definitely. At the Great Duck Islands, Maine, where these facts were gathered, the birds arrive early in March, and depart about September 1, according to the warden and lighthouse keeper, Captain Stanley, who has found that the first eggs are laid about the middle of May, while the first young begin to appear the second week in June.

In a census of one hundred nests of this gull taken on the island July 17, 1902, at the close of the breeding season, some interesting facts were brought out, which may be summarized as follows:

Abandoned empty nests, from which young have been reared	64
Abandoned nests with addled eggs	8
Nests with chicks outside	5
Nests with newly hatched chicks or pipped eggs	1
Nests with fresh or slightly incubated eggs	5
New nests, begun or completed	17
Total	100

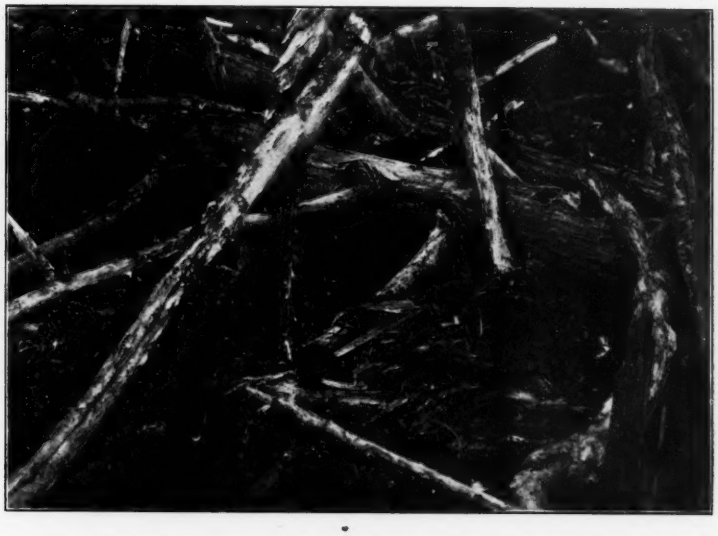


FIG. 17. IMPERFECT NEST OF GREAT HERRING GULL, illustrating the beginning of a new breeding cycle, when too late to be finished. Chips, grass, and roots have been brought to the new site. Great Duck Island, Maine, July 20.

Of the seventy-seven nests which had seen service in the season, eight only contained addled eggs. It was certain that none of the new nests, with or without eggs, could ever come to anything, and probably most were never finished. They are made to be abandoned, sooner or later, with the rise of stronger instincts. A new cycle is begun, but

FIG. 18. NEST OF GULL, illustrating the same tendency as that shown in Fig. 17, but where the old nest was "repaired," or used as a site for the new one. The body of a dead chick was worked into this nest, and the old bird was incubating an addled egg. July 22.

FIG. 19. GULL'S NEST ON ROTTEN LOG, with eggs starred and nearly ready to hatch, probably belonging to a bird which had earlier failed, but had renewed its activities in time to sucessfully rear young. July 20.

stayed at terms 3 or 4. Now it might be supposed that those nests which appear in middle or late July (Figs. 17–18) were the work of young birds, or of others which for some cause had not met with earlier success, but this is certainly not always the case. For the space of several days I watched a pair of gulls, which had large chicks to feed, and repeatedly saw them leave their young and begin the construction of a new nest about a rod from the old one. The female would split

FIG. 20. WHITE-HEADED EAGLE'S NEST OF THE FIRST YEAR, built in 1900, by the owners of the ærie shown in Fig. 21, which was destroyed the previous winter. The nest is considerably broader than tall.

chips, carry them to the chosen site, and go through the instinctive moulding and turning movements in the most approved and characteristic manner. The male even mounted the female, and was borne on her back like a circus-rider, in his evident attempt to perform an act

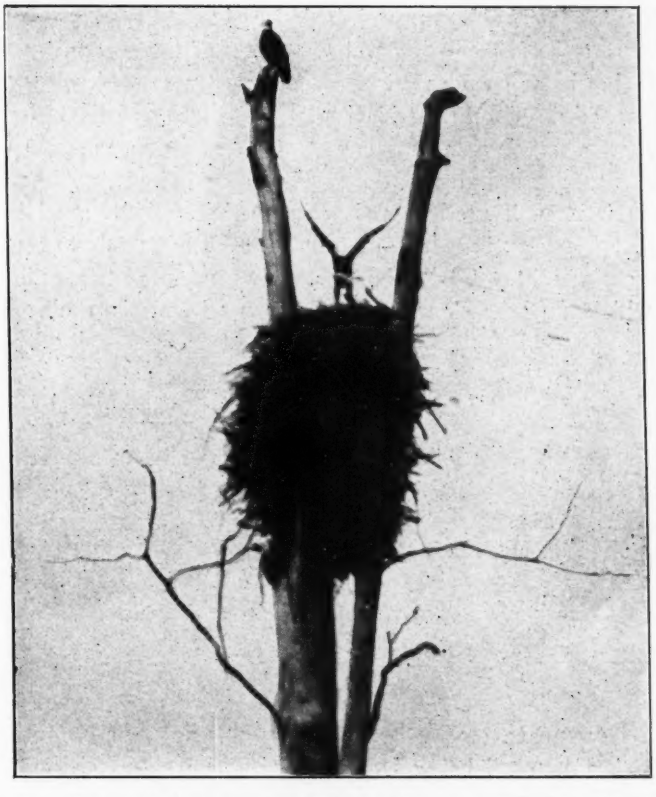


FIG. 21. ÆRIE OF EAGLE OCCUPIED FIFTEEN YEARS, and nearly twice as tall as broad; the predecessor of the nest shown in Fig. 20 In dead sycamore, three and one half feet in diameter at base; top of nest 77 feet from ground.

which is usually necessary. In this case, however, eggs were not destined to appear, and the new nest was eventually given up. This sporadic attempt at nest-building, while there are still chicks to be nursed, illustrates what we have described as the conflict of opposing instincts.

At the beginning of the breeding season in the gull, old nests are frequently reclaimed, and possibly by the same birds, though this has not been determined, or a new site is chosen, and a new nest built. If an addled egg is left after the others have hatched, "repairs" to the nest are frequently undertaken, and the old egg is either incubated for several days longer or it is buried out of sight. A pair of gulls, which was watched from the tent, had a single chick, and this one

lived only long enough to crawl out of its shell, while a second egg was bad. No sooner was the little one dead, than the work of reconstruction, that is building on the old site was begun, and the body of the chick, treated as so much nesting material, was soon buried under new layers of grass and chips (Fig. 18). This labor lasted for four days, or as long as I was able to watch it, but as in the other cases described, it was sure to be futile owing to the lateness of the season.

Fish hawks and eagles are known to return to their old nests year after year, adding fresh materials, that is, building on the old site, each season. An eagle's nest of the first year (compare Figs. 20 and 21) is broader than tall, but with the yearly increment of stubble and sticks added to its top, it gradually rises in vertical height, until becoming so much taller than broad, in certain situations it tends to topple over from sheer weight. The older of the two nests of the white-headed eagle, which are here shown (Fig. 21), was begun in the crotch of a dead sycamore, 77 feet from the ground at North Springfield, Ohio, in 1885, and occupied for fifteen years, or until January, 1900, when this ancient landmark was laid low in a storm. With the aid of photographs, taken in May, 1899,[2] and by actual measurements which I later made on the prostrate tree, the dimensions of this great nest were exactly determined. It was nine feet high and six feet in diameter, or three feet taller than broad, and contained rather more than three cubic yards of wood, earth and stubble. The new nest (Fig. 20), which was built in the spring of 1900, was examined and photographed in June of the same year; now after the lapse of a decade, it has much the appearance of the older nest, having risen greatly in height. Such a structure might be regarded as a kind of "multiple nest," being composed of increments, corresponding in number to the years of occupation, the last "nest" being built on the *site* of that of the previous year.

But a more interesting fact, if true, is the statement of Audubon[3] and others that ospreys and eagles often repair their nests in the autumn, as if in anticipation of the needs of the coming year. We can readily accept the fact, but not the interpretation, for if such a practise really occurs, it is plainly due to the rise of a new reproductive cycle, which is begun but soon checked. The sporadic return of the nest-building instinct at the close of the season is essentially the same in hawk or gull, and can imply no more intelligent forethought in one case than in the other.

[2] By Mr. H. E. Denio, of Milesgrove, Pa., to whose kindness I am indebted for their present as well as a former use.

[3] Audubon speaks only of the fish hawks, which he says but seldom alight on the ground, as "when they collect materials for the purpose of repairing their nest at the approach of autumn." "Ornithological Biography," Vol. I., p. 419, Edinburgh, 1831.

Desertion of the Young under the Impulse of Migration

The struggle of conflicting instincts is clearly shown when the normal cycle is brought prematurely to a close by the rise of the instinct of migration, when eggs or young are left in the nest to perish.

FIG. 22. A MULTIPLE—FOUR-STORIED NEST OF THE YELLOW WARBLER (*Dendroica Æstiva*), with a "parasitic" cowbird's egg in each compartment, but with proper eggs in the first story only, illustrating the successive breaking of the breeding cycle through fear, the beginning of three new cycles in succession, the new nest being built in each case, and probably through association, on the site of the old, thus admirably "concealing" the successive parasitic eggs. Original in the Field Museum of Natural History, Chicago.

The migratory impulse seems to "overlap," and finally to replace the proper parental instincts. The cycle is scamped near its close.

A classical illustration of this struggle of instincts was furnished by Dr. Jenner, in his "Essay on the Migration of Birds," published in 1824, and by the more circumstantial account given by Dr. John Blackwall in 1834, who called particular attention to "the occasional desertion of their last hatched broods by the swallow and house martin." Blackwall was a keen and discriminative observer, but his work[4] is so little known that I shall give a summary of his valuable and interesting results, under this head.

The swallow arrives at Manchester, England, about April the fifteenth, and the house martin on the twenty-fifth of the same month. They produce from two to three broods in the season, and are commonly found with nestlings in October, at a time when most of the migratory species have left the country. Many of these young which are led out of the nest, are deserted before they are able to follow their parents south, and have been found in a state of semi- or total exhaustion, late in the year. This, as Blackwall ingeniously suggests, may have given rise to the queer notion that the European swallows passed the winter season in a state of torpidity.

Blackwall's observations were begun as early as 1821, and when on November 11, 1826, twenty-two nests under the eaves of a barn in the Chapelry of Blakeley were carefully inspected, it was found that thirteen of this number contained either eggs or dead nestlings; five nests held eggs in every stage from the freshly laid to those at the hatching point, while the eight with young showed nestlings in every condition from that of hatching up to the nearly fledged state.

While the female swallow may exceptionally linger longer than the male, it should be noted that both parents commonly abandon their young at the same time. The same fatal conduct was also frequently observed in the sand martin, and Gilbert White, of Selborne, has given an interesting account of a swift, originally noted by him in 1781, which renders it practically certain that this bird may also desert its young, when the migratory impulse is strong. According to Pennant, who is quoted by Blackwall, the puffin is in like case also. The parental instincts of the puffin are strong, and the first young, which appear early in July, are guarded with the utmost care. But strong also is the instinct of migration, and when this emerges punctually at about the eleventh day of August, any young puffins which can not fly are left to the tender mercies of the peregrine falcon. This vigilant plunderer watches at the mouths of their holes, ready to seize them with mailed foot the moment hunger forces them to surrender. We may be quite sure that the young of the species enumerated above are not the only victims of the struggle of conflicting instincts. I have heard of similar behavior on the part of the domestic pigeons.

[4] "Researches in Zoology, Illustrative of the Manners and Economy of Animals," London, 1834; 2d ed., London, 1873.

III. Multiple and Superimposed Nests

We have referred to the towering ærie of the eagle and osprey as being, so far as instinct is concerned, a series of superimposed nests; indeed, any nest built on the site or over the ruins of a former abode, might be regarded in this light. When attachment to the site is strong, the bird, like the peasant in ancient Egypt and many of the earlier races of mankind, builds anew on the ruins of his former home, without taking care to clear the ground or raze such parts as still exist. The result is similar in either case—a series of superimposed structures of different ages, the height to which the pile may rise, depending upon the number of times the same site has been used.

The building of nest on nest, or of new nest on the site of the old, according to this interpretation, gives rise to the wonderful storied structures sometimes produced by the yellow warbler, or vireo, when plagued by the cowbird. That the intruding egg is buried out of sight is not due, however, to a feat of reason on the part of the suffering bird, but is the curious result of a nearly pure instinct, modified only by association. Fear breaks the cycle, but it is not always strong enough to break the habit of going to the old site. Instead of two or more supernumerary nests, more than one of which may contain eggs, and even stand side by side, as has been reported in the case of the phœbe, we have a series of *superimposed* nests, as is clearly illustrated in the remarkable four-storied structure of the summer or yellow warbler, here shown (Fig 22).[5] Each section of this composite, moreover, is seen to contain an egg of the parasitic cowbird, that in the first story being partially concealed by the warbler's eggs present.

According to this view, the new nest is not built *to conceal* the cowbird's egg, although it does so perfectly, any more than the addition of new materials to an osprey's nest in the fall is of the nature of repairs, although it may answer such a purpose admirably. The nest is built or "repaired" because the bird is at the opening of a new cycle, and is impelled to action by the rise of the building instinct. Whether the new nest is built upon the remains of the old, or close beside it, or half a mile away, must be attributed to the ordinary workings of instinct, modified by association and fear, when for some cause the normal cycle has been disturbed.

The so-called "cock nests" of the little marsh wrens may prove to be only another illustration of the supernumerary nests given above, but no opportunity has yet been offered to study these interesting structures. The fact that they may be used secondarily as sleeping apartments, if this is really the case, has no special significance. I have seen the abortive hole of a kingfisher so used, but a few rods from the

[5] For the use of this photograph I am indebted to the courtesy of Mr. F. J. V. Skiff, director of the Field Museum of Natural History, Chicago.

bank, which was later successfully drilled and occupied by the same pair.

The subject of compound nests is too long and involved for full discussion here, but from the builder's standpoint, which is that of instinct, I think there is ground for regarding such a composite structure as that reared on the cooperative plan by the ani or Savanna blackbird, as in reality a multiple nest.

IV. Eccentric Behavior; Robin offering String to Young

Under this head we shall describe a special case of what we have frequently referred to as the "overlap" or struggle of competing instincts. The incident happened in a neighbor's yard on One Hundred and Second Street, Cleveland. A pair of robins had nested in this yard, and successfully reared young, which were then hopping about in the speckled-breasted stage, and begging for food. On a certain occasion one of the parents was seen offering a long piece of twine to one of the youngsters, and trying to cram it into its throat. This robin would repeatedly gather up the string, as it would the coils of an angleworm, and offer it in the usual way, but string not being to the taste of this fledgling, it was as often rejected. After a time the old robin flew with the string into a tree.

With these facts in view, how shall we interpret such extraordinary behavior? We consider this case of the robin a most unusual and interesting exhibition of the conflict of opposing instincts, for according to this idea, the bird was at the close of an old reproductive cycle, and the beginning of a new one. She had fallen, as it were, between two stools. Impelled by the rising instinct of nidification, she gathered the string, when aroused by the calls and sight of her young she was induced to offer it; again under the sway of the building instinct, she flew with the string to a tree. We can judge of the sequel, although unfortunately observation on the robin's conduct stopped at this point. The popular interpretation that the bird was crazy gives place to something which we can measurably understand, or coordinate with other related facts. On the other hand, what a commentary such an act furnishes upon the effective intelligence of birds, when under the sway of powerful instincts. Does not the robin know a "hawk from a handsaw," or a worm from a piece of string? The behavior of the great herring gull with chicks still requiring her care, in going through all the motions of nest-building, and returning to her young again, would seem to be similar in all essential respects.

V. Premature Laying of Eggs, Omission of Nest-building and Parasitism

Lack of attunement between the appearance of the nest and eggs, or terms 3 and 4 of the cycle is very common. Too frequently the egg

"anticipates" the nest. Every one who has given much attention to the activities of birds in the field must have found isolated eggs lying on the ground. Such prize packages are probably more common than we might be led to suppose, for they can not long exist wherever snakes, rodents and other prowling animals abound.

With most birds the act of prematurely dropping an egg can be only a sporadic or casual variation. Without doubt, in the course of time a proper nest is built; eggs are laid, and the normal cycle is rounded out to completion. It is quite possible, on the other hand, that all such eggs are not immediately neglected, but that they are sometimes carried away, and "concealed" by dropping them in another bird's nest, although we have no observation to support such a view directly. It is known, however, that certain birds, such as the black-billed cuckoo, will upon disturbance remove its eggs from the old nest to a new one or to a place of safety.[6] It is also certain that the premature egg is at times laid direct in another bird's nest, which the intruder will often strive to possess by force, and may even succeed. Thus, Davidson, who is quoted by Bendire, found a black-billed cuckoo and a mourning dove sitting on a robin's nest together. This nest was in reality double, and contained two eggs each, of the cuckoo and dove, and one of the robin. The cuckoo managed to get possession of the nest before the robin had finished her work, and filled it with rootlets, but the robin held its ground long enough to deposit an egg. The fact that the cuckoo had "filled it nearly full of rootlets" is a very interesting circumstance, for it shows how completely instinct held the reins of action. This robin's nest seems to have served as a site on which the cuckoo strove to erect one of its own. The dove, noted for its strong parental instincts, had evidently come last, and her eggs were the only ones in which incubation had not begun.

Such a case seems to present us, as in a picture, with one of the steps in the process through which the most remarkable of all the known instincts of birds, that of parasitism, has been brought about.

Certain cowbirds of the new world and cuckoos of the old steal the nests of other birds, but usually only long enough to deposit an egg of their own, which is left to its fate. If tolerated, as is apt to be the case, the stranger is hatched with the other eggs, and the owner of the nest assumes the rôle of nurse or foster-parent. If a cowbird, the foundling soon smothers the proper young, and if a cuckoo, it evicts them. The cuckoo seems to react to a contact stimulus of a disagreeable kind, and when from one to three days old, while still blind, it strives to get egg or nestling on its broad, depressed back, and

[6] That other species of birds occasionally remove their eggs when disturbed can not be doubted, and they probably do it with their bills. The king penguins of the Antarctic are said to guard their single egg by carrying it in a pouch or fold of the skin, developed in either sex, between the legs.

hitching its way, thus laden, up the wall of the nest, throws them overboard. If such a bird is replaced after a time, the same movements are repeated. With the coast thus clear, the little "parasite" can monopolize the attention of its nurse, and grows apace, being attended with all the care which is bestowed on a legitimate child. As Philemon Holland has quaintly rendered the account of the elder Pliny:

"And this yong Cuckow being greedy by kind, beguiling the other yong birds and intercepting the meat from them, groweth hereby fat and faire-liking: whereby it comes into speciall grace and favour with the dam of the rest, and nource to it. She joieth to see so goodly a bird toward: and wonders at her selfe that she hath hatched & reared so trim a chick. The rest, which are her owne indeed, she sets no store by, as if they werr changelings: but in regard to that one, counteth them all bastards and misbegotten." Having followed our elder worthy thus far, we should give his sequel also, even if he steps from observation to fable: "yea, and suffereth them to be eaten and devoured of the other even before her face: and this she doth so long, until the yong cuckow being once fledge & readie to flie abroad, is so bold as to seize on the old Titling, and to eat her up that hatched her."

It is evident that this practise of nest-stealing, somewhat ambiguously called "parasitism," could never become very popular or widespread, for it would soon break down of its own weight.

For over two thousand years, or since the time of Aristotle, who was the first to leave a permanent record of this propensity in the European cuckoo, the question has been asked, How could such a habit arise? and the answers have been various, and far from satisfactory. The key to the matter lies, as we believe, in the cyclical instincts, and in the disturbances to which they are prone. When the normal rhythm is generally disturbed or permanently changed, new instincts and even new structures may arise, which serve as a counterbalance to the changes wrought.

We believe that the instinct of parasitism got its start through lack of attunement in terms 3 and 4, of the reproductive cycle, and that it has passed through essentially the following stages: (1) The egg forthcoming before there is a nest ready to receive it, a condition sporadic in very many, if not in most modern birds, due to unknown causes, such as lead to a premature growth of the ovary, or to a disturbance of certain instincts. There is a loss of eggs, although a nest may be eventually built, and young reared in the season. (2) The eggs are ready before the nest, and many are lost by dropping them on the ground, while others are laid in stolen nests. A proper nest is sometimes built, but whether young are ever reared, will depend upon circumstances. This stage is exemplified by the Argentine cowbird (*Molothus badius*), described by Hudson, which commonly wastes its eggs, scattering them in all directions, yet it will steal a nest upon

occasion, or build one of its own. It even laid eggs in artificial nests, which Hudson placed in trees to test its propensities in this direction. (3) The common practise of stealing nests of other birds, but of holding them, as a rule, only for laying its own eggs, as illustrated to-day by the North American cowbird (*Molothrus pecoris*). The instincts of the intruder seem to be satisfied by "concealing" its eggs, or simply laying them against the wall of another bird's nest, and leaving them. At this stage the European cuckoo, we may suppose, not only frequently dropped its eggs on the ground, but occasionally tried to incubate them, and may have even attempted a rough nest. At this stage also the normal tendency to lay eggs at daily intervals was possibly disturbed, and the interval became irregular, with the gradual establishment of a longer rhythm.

At this point several roads would seem to be open, for the resources of nature are not limited to one course. Parasitic or non-brooding cuckoos have "chosen" one, so to speak, the brooding American species another, and if we are to accept the accounts, certain owls, which breed in the far north, successfully rear young in the short Arctic summer, with an interval of a week or more between each egg. Yet there can be little doubt that an undue lengthening of this interval would seriously interfere with nest-life in many species, and break the tendency to guard the egg. All would seem to depend upon the correlated instincts of parent and child. With an interval of from five to seven days, which has been credited to *Cuculus canorus,* self-brooding would be impracticable without a change in its instincts, for it migrates in July. While it is certain that the egg-laying interval was gradually extended in this bird, it is not known at what corresponding point the parasitic practise was finally established. Certain it is, however, that then as now, the egg, whether laid direct in a nest or dropped on the ground and subsequently conveyed to one, was abandoned. The American brooding cuckoos (*Coccygus erythropthalmus* and *C. americanus*), although suffering a similar disturbance in the brooding interval (of one to three days), have adjusted these differences by another course. The young which are hatched in succession, also leave the nest in succession, when one week old, and enter upon a climbing stage which lasts a fortnight. In this way the brood is divided into two groups, and any untoward effects which might result from a marked difference in age of the nestlings, is avoided. The greatest disadvantage of such a mixture, in the nest of this species, would seem to lie in the fact that the oldest and strongest usually succeed in holding up most of the food. We may add that the American cuckoos have never advanced far beyond the first stage, as designated above, although they have suffered a disturbance in the normal rhythm of egg-production, and that the parental instincts are as strong with them as in passerine birds. The

study of their habits gives no support to the idea advanced by Darwin, in his "Origin of Species," that they are passing along the same road to parasitism already traversed by their European relative. I do not know whether the American cuckoos ever built a better nest or not, but it is certain that the present structure is adequate to their needs, and affords no evidence of a waning instinct of nidification. (4) The final stage of the parasitic instinct among the Cuculidæ is presented by their famous European representative, *Cuculus canorus,* in which the instincts of both young and adult have become so specialized that to describe them at all adequately would require many pages. One hundred and nineteen different species of birds have been the prey of this parasite, the eggs of which have become reduced in size and highly variable in form and color. The commonest dupes are birds of small size, like the hedge sparrow and titlark; but one egg is laid in the same nest by the same bird, and this is often similar in size and coloring to those of the prospective nurse. The egg is deposited stealthily in the stolen nest, and in the absence of the owner, either just before or just after the proper eggs have appeared, or it is first dropped on the ground and conveyed to the nest in bill or gullet, by which the range of accessible nests is greatly increased. These and other remarkable practises of this bird have been fully described in a paper on the "Life and Instincts of the Cuckoo," shortly to appear.

All travelers who have studied the ostriches of South America and Africa in the field speak of the great numbers of their eggs which are annually wasted both in and out of season by dropping them over the plains or around their nests. If this is a secondary character, it must have come from a disturbance of the normal cycle, quite similar to what we have found in cuckoos and starlings. In this case adjustment seems to have been effected in quite a different manner, for we find the male taking upon himself almost the whole duty of incubation and care of the young. Even the wasted eggs, at least in the neighborhood of the nest, serve a secondary use as food, for the young soon break them open and devour them.

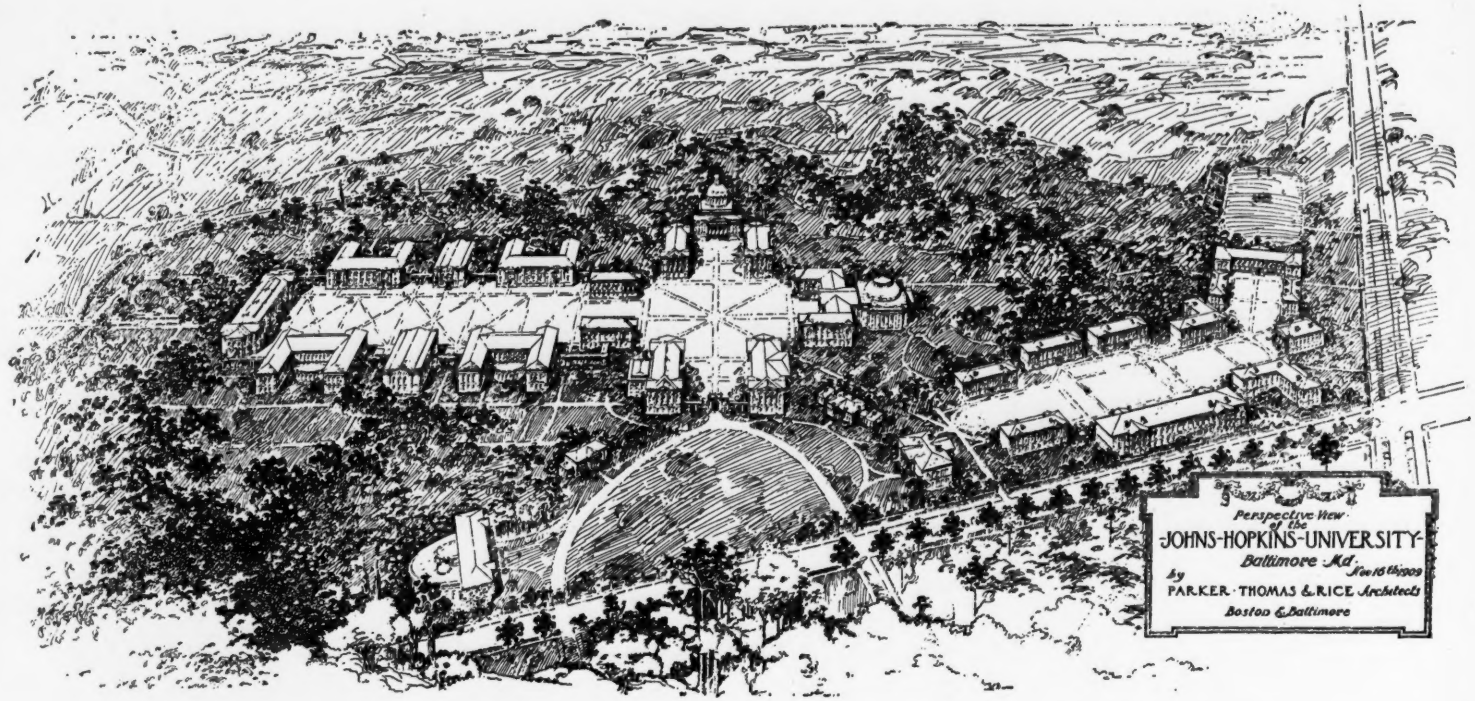
We can not discuss with much profit the remarkable breeding habits of the megapodes of Australia and the East Indies, referred to earlier in this paper, until naturalists have made more detailed studies upon the various species. The notes which follow are purely tentative, and are offered by way of suggestion. The true megapodes build huge mounds of earth and leaves, which serve as incubators for their eggs, and the young, which may or may not be subsequently tended by their parents, are in most cases able to run or fly from birth, or when they emerge from their mound. The moleos or "maleos" deposit theirs in black volcanic sand which is both damp and warm, either by the seashore or in the vicinity of warm springs in the interior. In any case

both birds instinctively secure the two requisites for successful incubation—even warmth and moisture—though in different ways.

That the brush turkeys are descended from stock which possessed the instinct of incubation is rendered probable from the fact that they are gallinaceous birds, allied to the curassows, wild turkeys and grouse, all of which build some kind of a nest and brood their young at the present time. Further, the fact that the same mound is used continuously by the same birds, whether by more than one pair or not, and is added to year after year, like the ærie of an eagle, and that in the ocellated megapode, at least, the adults remain in the vicinity of their mound and tend their young after leaving it, all suggest that this mound must be regarded in the light of a nest, however modified from the typical structure. From the stage seen in the ocellated magapode, it is only a step or two to that found in others, where the parents never see their young, for which they make ample provision, any more than does a turtle or a mud-dauber wasp.

More aberrant still, but in the same direction, is the behavior of the moleo, in which as in the parasitic cuckoos, other changes have arisen, which would render self-brooding difficult if not impracticable. Their large eggs, six to eight in number, are said to be deposited at the extraordinary interval of ten to twelve days, so that a period of three months would elapse, between the laying of the first and last. Again, unlike the fowls and birds generally, no turning of the eggs during incubation is necessary.

While nothing is certainly known concerning the history of these peculiar instincts of the megapodes, it is not unlikely that, as in cuckoos and cowbirds, they have arisen through the modification of earlier and more uniform instincts which the ancestors of all modern birds seem to have possessed in common.



A Perspective View of the Proposed Buildings on the new Site of the Johns Hopkins University.

THE PROGRESS OF SCIENCE

THE JOHNS HOPKINS UNIVERSITY

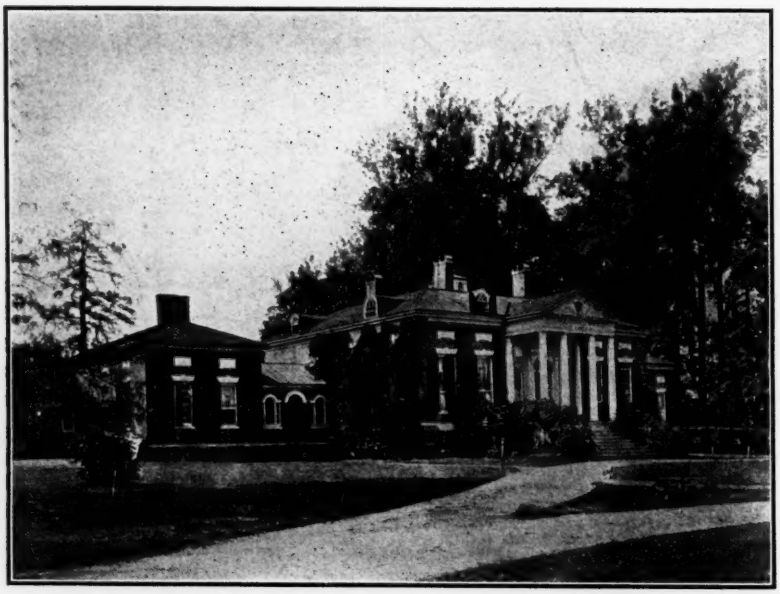
THE authorities of the Johns Hopkins University have issued a pamphlet in the interest of the endowment and extension fund which they need and should have. The General Education Board has undertaken to contribute $250,000, on condition that $750,000 be obtained from other sources: but the university aims at more than this. It would remove to its new site and would complete its university organization by the establishment of a school of higher engineering, a law school maintaining the standards of its medical school, and a school for the training of teachers. It would also obtain an endowment fund for its college, establish a department of preventive medicine and erect a building for pathology.

When the Johns Hopkins University celebrated the twenty-fifth anniversary of its foundation in 1902 a site was given to it which cost $500,000, and is now worth twice as much. The hundred and twenty acres, finely situated two miles from the center of Baltimore, admit of picturesque development beyond the possibilities of any other city university. We reproduce a plan of the site with pictures of two of the buildings which it is intended to erect first and of the Carroll mansion on the grounds, which is to serve as a model for the architecture. A botanical laboratory and garden and an athletic field are already in use. The administration and academic buildings, shown in the illustration, and laboratories for chemistry, physics, geology and botany must be erected promptly. These with the power plant, grading, etc., will cost about $1 200,000, towards which can be used the proceeds of the sale of the present site and buildings.

So long as a national university is not established in Washington, there is needed a great university at Baltimore. The states to the south and west are not adequately supplied with institutions of higher learning, and for a long while the Johns Hopkins University will set a model for that region, whose industrial development will surely be followed by an intellectual renaissance.

The Johns Hopkins University deserves well not only of Baltimore and Maryland and the south, but of the whole country. When it was opened on October 3, 1876, there were colleges in this country, but no universities. The idea of the university was doubtless in the air, but it was first placed on a solid foundation at Baltimore. Remarkable wisdom was shown by

ADMINISTRATION AND ACADEMIC BUILDINGS WITH ENTRANCE TO QUADRANGLE.



THE CARROLL MANSION AT HOMEWOOD, built in 1803, the architecture of which will be the key-note for the new buildings.

President Gilman and his advisers, not only in deciding that the Johns Hopkins should be a university rather than a college, but also in adopting standards and ideals, which have not elsewhere been paralleled. The smallest possible amount of money was spent on buildings, and no attempt was made to cover all kinds of subjects. A small group of professors, each a man of distinction—Rowland, Remsen, Sylvester, Martin, Brooks, Gildersleeve—were brought together, adequately paid and given complete freedom. Fellowships and means of research and publication were provided; the ablest students in the country were drawn to Baltimore. These men are now in nearly every academic center of the country, and the influence of the Johns Hopkins and of the university ideal is everywhere.

Not only in 1876, but again in 1893, and again with comparatively modest resources, the Johns Hopkins set university standards by the establishment of its school of medicine. Again a small group of distinguished men—Welch, Osler, Howell, Mall—were brought together, and for the first time in this country there was a school of medicine on a proper university basis. Like the graduate faculty of philosophy this school has set a model, which other institutions are now following.

The country can only in slight measure repay the Johns Hopkins University for its great service by giving it the money it now needs. Columbia and Princeton have each received $5,000,000 within the past year; the Johns Hopkins should have as much. If the writer of this note—who is one of those who came under the influence of the university in its great days—had despotic control of the vast wealth of the country, he would assign to the Johns Hopkins University as many millions as it might ask. But it would not be for new buildings and new departments. It would be on condition that the standards set in 1876 and 1893 should be maintained, that we should have a university where every teacher is a great man, free to do his own work in his own way.

MEDICAL EDUCATION IN THE UNITED STATES

THE Carnegie Foundation has issued a bulletin on medical education in America, which is likely to do good service in attracting attention to the low standards and inadequate endowment of many of the medical schools of the United States. On behalf of the foundation, Mr. Abraham Flexner has visited every one of the 155 medical schools, and gives a brief description of each. The conditions in each state are summarized, and plans are proposed for their improvement. This detailed report is preceded by an introduction by President Pritchett and by fourteen chapters by Mr. Flexner on the whole subject of medical education in this country, beginning with a historical sketch and ending with the education of the negro. The bulletin, which extends to 347 pages, may be obtained by sending seventeen cents for postage to the foundation.

The conditions of medical education in the United States have been investigated with equal thoroughness by the council on education of the American Medical Association, and are well understood by experts. There are too many inadequately trained physicians in the country, and one of the principal difficulties is the existence of proprietary schools dependent on the fees of students. Physicians are ready to be professors in medical schools for the title and connections. When the school depends for its support on the fees, low standards are likely to be adopted in order to attract students. It was at one time possible to conduct a proprietary school with tolerable efficiency, as can now be done in the case of law, but with the development of laboratory and clinical methods, the cost of a satisfactory medical education can not be met by fees. It is certainly a scandal that one third of our medical schools have incomes below $10,000, all from fees, that in some cases there are as many professors as students, and that many students do not have even a high school education. One school actually exists with twenty-six professors and a total income of $1,060.

But while every one knows and admits the evils, the remedy is not clear. Though Dr. Pritchett and Mr. Flexner have obtained their medical education by a short course, they have had expert advice and their general point of view is sound. We need several university schools of medicine emphasizing research and demanding long preliminary preparation, the schools for the training of the great mass of practising physicians should require a training in science and the languages equal to two years of college, the schools in the south can not at present reach this standard, but should require a preparation equal to a four-year high school course. Each school should have adequate laboratories for anatomy, physiology, chemistry and pathology under the charge of professors and instructors who give their whole time to the work of teaching and research. The clinical departments should be under the charge of professors whose practise does not interfere with their teaching, and there should be a suitable hospital and dispensary controlled by every school.

But how are we to reach these standards? We are slowly approaching them. When the Johns Hopkins Medical School was opened seventeen years ago, it was the only well-organized department of medicine in the country. With Harvard it still maintains preeminence; but there are now some thirty schools which give adequate training for the medical profession. The commercial schools are closing and being merged every year, for by the nature of things they can not last when they do not pay. When good schools are adequately endowed in all sections of the country, students will naturally frequent them. The states can accomplish more for the profession of medicine and the people by support-

ing good medical schools than by suppressing those that are poor or by formal restrictions making it difficult to enter the medical profession.

ROBERT KOCH

In the death of Robert Koch, the world loses one of its greatest men, whose service to it has been beyond all measure. It is not easy to realize the changes in bacteriology and in medicine which have taken place in the course of the past thirty or forty years, or how largely these are due to this one man. Koch was preceded by Pasteur and Lister, but bacteriology and the germ theory of disease scarcely existed when in 1876 he published his paper announcing the isolation of the bacillus of anthrax. He was at that time a country physician, but had had the advantage of studying medicine at Göttingen under Wagner and Henle. One wonders whether the hundred and twenty-five thousand physicians now practising in the United States would not produce some men of the type of Koch if they had been turned in the right direction at the university. If so, how small would be the cost of such schools in comparison with their value.

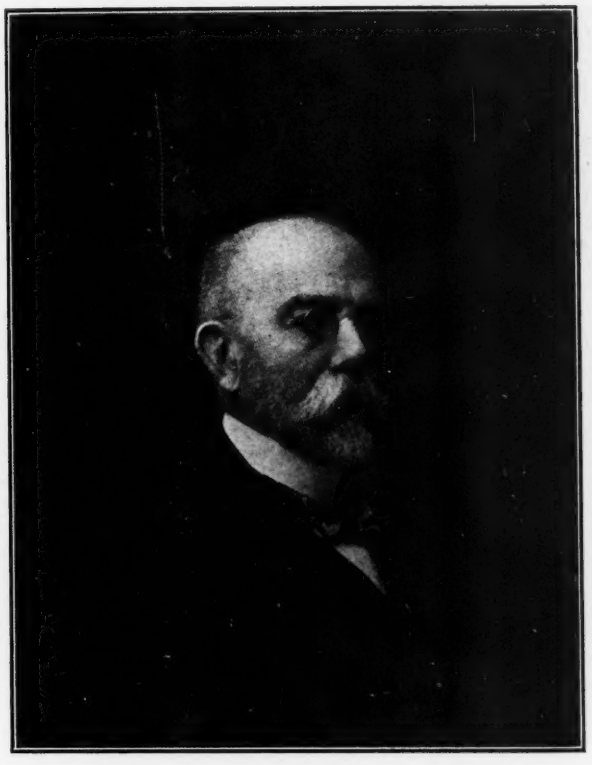
Koch published in 1878 a second important paper on infectious diseases, and was in 1880 given opportunity to devote himself to research work by being appointed to the Prussian department of public health. In his small laboratory at Berlin, with Loeffler and Gaffky as assistants, he developed the methods of bacteriology by cultures and disinfection, and in 1882 made announcement of the far-reaching discovery of the bacillus of tuberculosis. A year later he visited Egypt and India and discovered the comma bacillus of cholera.

Koch continued his study of tuberculosis, cholera and other diseases, not only from the point of view of laboratory science, but devising and applying means to combat them. In 1880 came the discovery of tuberculin, the curative power of which was exaggerated, not so much by Koch as by the general public. Koch was fully justified by its diagnostic value; his statement of its curative properties was cautious, and if it has not fully justified even these modest claims, it has led to the whole subject of vaccine therapy, including diphtheria anti-toxin, and may still fully confirm such claims as Koch made for its curative value in tuberculosis. Koch was again criticized when in 1901 he announced the discovery that human and bovine tuberculosis are not identical, but time appears to have proved that he was correct in his facts and also in his claim that the main efforts should be directed toward preventing human contagion.

In later years Koch devoted himself largely to tropical diseases and accomplished much by his studies in Africa and Asia of parasitology, bacteriology and hygiene, investigating rinderpest and surra, the bubonic plague, malaria and sleeping-sickness.

Such rewards as a scientific man may have were given to him. He was appointed in 1885 professor of hygiene in the University of Berlin and director of the Hygienic Institute, then newly established. In 1891 he was appointed director of the new Royal Institute for Infectious Diseases, and became an honorary professor in the university. This institute now forms a part of the Rudolf Virchow Hospital, and is known as the Koch Institute. Koch received the Nobel prize in medicine in 1905. But the rewards that could be given to him were insignificant beside his services.

Of the world's debt to Koch the *Journal* of the American Medical Association says: "But death has claimed the master and the world has lost its leader in the struggle against infection. Endowed with a mind of the first order, and animated, beneath a quiet, impassive and meditative exterior, by a spirit of unceasing but wonderfully well-regulated activity, which drove him on as by an internal



ROBERT KOCH.

fire from achievement to achievement, he made his own age preeminent over all the ages that have gone before for advances in the exact knowledge of the causation and prevention of infectious diseases. Rarely, if ever, have so many discoveries of such decisive importance to mankind emanated from the activities of one person; yet he served with all humility of mind. He simply tried to do his duty, being, as he said, fortunate to find sometimes the gold among the gravel of the road which is open to every one. When we consider the advancement medicine owes to Robert Koch and the endless and inestimable blessing which has come to mankind through his work and life, there comes an overpowering sense of admiration, reverence and gratitude."

SCIENTIFIC ITEMS

WE record with regret the deaths of Dr. George Frederic Barker, emeritus professor of physics in the University of Pennsylvania; of General Cyrus Ballou Comstock, U. S. A. (retired), the eminent engineer; of Professor William P. Blake, known for his contributions to geology; of Professor Stanislau Cannizzaro, the distinguished Italian chemist, and of Lieutenant Boyd Alexander, the African explorer.

NEW YORK UNIVERSITY has given its doctorate of laws to Dr. Henry Mitchell MacCracken, who retires from the chancellorship of the university.—Sir David Gill, K.C.B., F.R.S., has been appointed a knight of the Prussian Order of Merit.—Lord Rayleigh has been promoted from a corresponding to

a foreign member of the Berlin Academy of Sciences.

FOLLOWING the advice of its advisory board, the Wistar Institute of Anatomy has established a department of embryology, and Professor G. Carl Huber, of the University of Michigan, has been called to this chair.

BY the will of Isaac C. Wyman, of Salem, Mass., a graduate of Princeton College, most of his estate is bequeathed to Princeton University, to be used for a graduate school. Mr. John M. Raymond, of Salem, Mass., and Professor Andrew F. West, dean of the Graduate School, are the trustees. The value of the bequest is estimated at $3,000,000. Mr. W. C. Procter has renewed his gift of $500,000 for the Graduate College. A great graduate school is thus assured at Princeton.

AT a meeting of the trustees of the General Education Board, held on May 24 in New York City, $682,450 in appropriations was voted. Of this sum $538,000 was appropriated conditionally for the endowment funds of eight colleges, $113,000 for the furtherance of demonstration work in agriculture throughout the southern states, and $31,450 for the salaries and expenses of special professors of secondary education in the several state universities of the south. The appropriations voted in support of college endowments raised to $5,177,500 the sum already spent in this direction. The seventy colleges that have received these endowments during the last four years of the board's activities have each raised sums in endowment which, taken with the board's gifts, aggregate $23,670,500.